SUBJECTIVE EVALUATION OF AQUATIC HABITATS

Developed by: KANSAS DEPARTMENT OF WILDLIFE & PARKS, ENVIRONMENTAL SERVICES SECTION (Revised 2004)

This subjective evaluation procedure can rapidly evaluate aquatic resources through a series of components designed to provide a holistic evaluation of the physical, biological, and chemical parameters of the aquatic system. This document contains the evaluation's components along with scientific logic and guidelines for their usage. The components were selected to provide uniformity and consistency when evaluating different aquatic habitat types (i.e. ephemeral vs. intermittent vs. perennial streams; small impoundments vs. larger lakes) throughout broad geographical regions in the state of Kansas. The assessment will provide a quantitative value (R) from 0.0 to 10.0 that represents the quality of the habitat being evaluated compared to the optimal habitat (i.e. reference site) type for the geographical area in question, with a score of 10.0 representing reference site conditions. In certain circumstances, an evaluator may determine that the score does not represent the habitat characteristics either by over- or under-valuing the habitat. In these cases, adjustments to the composite score will be acceptable, provided adequate documentation of those unique features are provided (i.e. narrative description, photographs, etc.).

AQUATIC HABITATS

There are two main habitat types that this procedure is designed to evaluate:
(see individual guidelines for habitat descriptions)

1. Streams
2. Impoundments

For the aquatic habitat types the subjective guidelines for judgement rates are:
Excellent Habitat = 8.0 - 10.0; Good = 5.6 - 7.9; Fair = 3.1 - 5.5; Poor = 0.0 - 3.0

STREAM EVALUATION

Streams provide unequivocal habitat to aquatic, semi-aquatic, and terrestrial wildlife native to the state of Kansas. The fluctuations of abiotic and biotic conditions that exist within flowing waters often can change habitat conditions rapidly; therefore, it is important to assess as many of these variable parameters as possible in order to properly evaluate the year-round conditions that influence the quality of habitat the stream provides. This assessment, like many stream assessments used around the country, incorporates geological and morphological habitat characteristics, floodplain and riparian condition, biological components, and water chemistry parameters into the protocol. By merging these variable characteristics of a stream into a single subjective assessment we can rapidly produce a quality determination of the habitat characteristics and ecological condition through a single site visit.

A. Physical Habitat Key

1. ***Stream Type –*** The type of stream identified by this component is categorized based upon flow characteristics and the importance of the stream to the aquatic community. Although ephemeral and intermittent drainages are essential to the function of a watershed, they are not provided a point value equal to perennial streams due to the fact they typically do not provide year-round habitat for aquatic organisms. Evaluators should take into account regional and site-specific climatic conditions (i.e. extended drought, recent heavy rains, etc.) when determining the flow characteristics of a stream. Multiple point values are provided for various stream types to efficiently characterized differences in quality within that stream type. For example, some intermittent streams have subterranean input that sustains flow at a higher rate and for a longer period of time than other streams. The evaluator may choose to provide a higher score within the stream type for this system.

Ephemeral stream - A drainageway that may or may not have a well-defined channel that carries flow only during periods of surface runoff. These drainages are not hydrologically connected to subsurface inputs (i.e. springs, subterranean flow, etc) and often lack a well defined channel with easily identifiable bed and banks.

Intermittent Stream - A drainageway with a well-defined channel that generally flows only during a part of the year. It continues to flow after cessation of surface runoff, but effluent ground water (springs/subterranean flow) will not sustain flows through moderate periods of little or no precipitation. It may contain reaches of perennial flow or have permanent pools that support aquatic wildlife.

Perennial Stream - A drainageway with a well-defined channel which perennial flow persists throughout the length of the drainage during normal climate conditions. The permanency of flow is usually attributable to ground water effluent. In Kansas, many streams considered perennial may cease surface flow during periods of seasonal drought.

2 – 4. ***Substrate types, Number of various substrates, Percent Embeddedness*** - Substrate can vary significantly in a stream, horizontally, vertically, and lengthwise throughout a reach, with frequent changes relating to fluctuations in flow regimes. Both inorganic and organic material is included in substrate composition, and will vary spatially and temporally. Vertical variations may occur seasonally as with the presence of leaf litter in the late fall through the spring, covering gravel or cobble substrates that would be visible in the summer. In addition, temporal variability related to sediment deposition and accumulation of detritus during periods when spates have been absent (i.e. no 'flush' effect) may influence the evaluator's conception of substrate composition. Best professional judgement on the substrate parameters should address these dynamic circumstances to provide the optimal score the habitat provides for aquatic organism on a consistent basis.

Waters (1995) reports on several studies that have demonstrated that substrate and biological diversity are often correlated, with substrates having greater surface area and interstitial space (i.e. gravel, cobble) indicative of greater aquatic macroinvertebrate and vertebrate diversity. Exceptions do exist. In cases where a stream's substrate is monotypic, but not indicative of less-than optimal habitat, the evaluator should provide a score that reflects the site's substrate quality in relation to the geographical region in which the evaluation is being performed. For example, if an evaluator is assessing a high-quality stream in Southwest Kansas in which the substrate is homogenous throughout the reach with a sand, the evaluator can provide point values for components 2 – 4 that reflect a higher quality substrate profile than if the site was assessed strictly according to the provided values for sand substrate. The evaluator should consider if the lack of substrate diversity is hindering the habitat quality of the stream for the geographical area the site is located in. If not, then exceptions can be made and appropriate points provided along with a brief explanation.

Silt deposition may influence substrate composition if significant high-flow events have been absent during drought periods to provide a 'flush' effect on the site. This often leads to deposition of fine sediments that become embedded within the interstitial spaces between substrate particles; thereby depleting the hyporheic zone of subsurface flow of oxygen-containing water through the interstitial spaces beneath the stream bed (Alan, 1995). These habitats are particularly productive in riffles where numerous benthic macroinvertebrates inhabit these areas and require substrates unimpeded by excessive sedimentation. Alan (1995) cites two studies by Bjornn et al. (1974 & 1977) that illustrate the effects of embeddedness on benthic macroinvertebrates. At embeddedness levels greater than one-third (i.e. more than 33% of the substrate fixed by surrounding sediment) insect abundance declined by approximately 50% for riffle inhabiting taxa. The evaluator should consider these variables and use professional judgement when scoring the components related to substrate.

5. ***Sinuosity*** - Sinuosity is used as an indication of how a river has adjusted to the slope of its valley (Rosgen,1996) and is measured as: **Channel Length ÷ Valley Length**. The degree of sinuosity is related to channel dimensions, sediment load, stream flow, and the bed and bank materials. A sinuosity of 1 indicates the stream is flowing in a straight line and would typically be indicative of some anthropogenic activity such as channelization. Most low-gradient streams that are functioning efficiently in transportation of bedload will have a sinuosity value of 1.5 or greater (Rosgen, 1996; Cole, 1994; Gordon, et al., 1992). The evaluator may need to consult an aerial photograph to determine which component selection to choose.

6. ***Pool-Riffle Spacing***- In low-gradient streams, pool-riffle sequences (along with sinuosity) are indicative of the meander geometry of a stream profile. Leopold et al. (1964) first noted the linear sequencing of pools and riffles in meandering alluvial streams as typically 5-7 bankfull widths (bankfull width is the incipient elevation on the bank where flooding begins – Rosgen, 1996). A complex of both a pool and a riffle, common to an individual meander wavelength, can be expected to occur every 10 to 14 bankfull widths. The evaluator should estimate the bankfull width, and subsequently, the channel distance in which a riffle-pool complex would occur. Quality estimation should be attained on the frequency of pool-riffle spacing that will allow the evaluator to determine whether the stream fits this profile. Keep in mind that pool-riffle sequences are the result of particle sorting and require a range of sediment types to develop. For this reason, regular pool-riffle alterations may not be apparent in sandy bottom streams (Allan, 1995). In these instances, the evaluator should rely on sinuosity to determine if the meander wavelength profile is indicative of a properly functioning alluvial stream.

7. ***Stream Bank Erosion*** - Bank erosion is a natural river adjustment process; however, rates of lateral migration can be accelerated in response to anthropogenic activities such as restriction of the floodplain, removal of riparian vegetation, altered hydrology patterns within the watershed, livestock trampling, and channel modifications. Recent studies have illustrated that the contribution to total sediment yields from bank erosion has been greatly underestimated (Rosgen, 1993; Rosgen, 1996). The evaluator should provide an estimation of the extent of streambank erosion for both the left and right banks and record an average score for the reach. (Bank erosion rarely differs between banks unless some stabilizing structure(s) have been placed on the banks.

8 – 9. ***Type and Amount of Instream Cover*** - The type and amount of instream cover influences a variety of life history requirements for aquatic organisms such as shelter, food, reproductive areas, as well as increases the number of available niches, thus in turn increasing the biological diversity within a stream. Competition influences the distribution and abundance of stream-dwelling organisms; therefore, species have evolved to partition resources to fit their ecological requirements. This component operates under the connotation that increases in the abundance of instream habitat cover result in a more ecologically diverse stream by providing the array of habitat features necessary for species abundance and diversity.

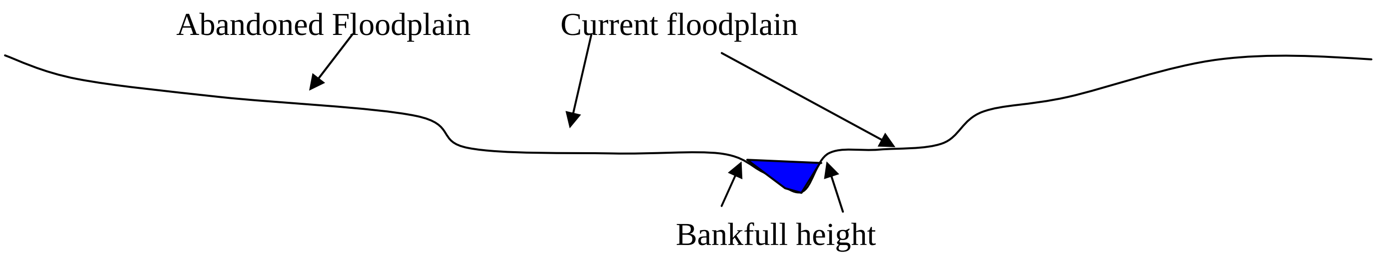
Habitat features should be stable (not transient) and be available for full colonization and maintenance of populations by epifauna and/or utilization by fish or amphibians for a specific life history requirement (i.e. cover from predation, shelter during spates, food supply, reproductive area, etc.). Temporal variability may dictate what features are available at the time of the evaluation; however, habitat features outside of the wetted channel should not be discounted. For example, an evaluator is assessing an intermittent stream in late August. The stream is bordered by riparian woodlands and root wads extend into the active channel, however, at the time of the evaluation the stream has been reduced to a series of pools scattered along the reach, none of which border any of the rootwad masses. The evaluator may choose to include rootwads as an instream cover type if he/she believes the habitat provides important cover to fish and/or becomes an area of invertebrate colonization during the periods (i.e. spring/early summer months) when flow inundates the root wads.

10. ***Channel Modifications*** - A number of channel modifications can affect the quality of the stream reach in question. Destruction of habitat, fish migration barriers, increased pollution, and altered hydrology are just a few results of man-made channel modifications that degrade lotic ecosystems. The evaluator should score the component based on the extent any modifications are impacting the ecological function and condition of the stream.

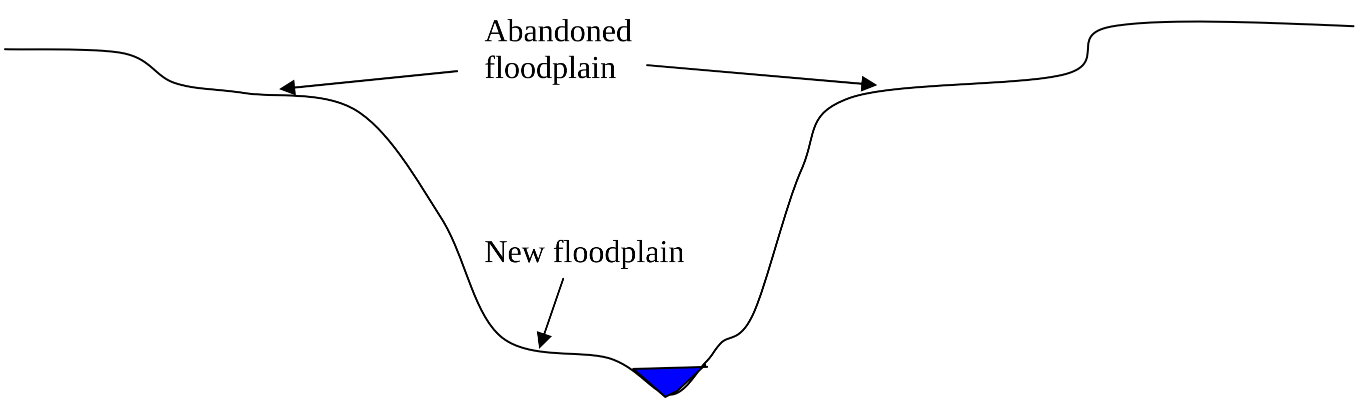
B. Riparian/Floodplain/Land Use Key

1. ***Historical Floodplain Available for Inundation & Percent Covered by Native Vegetation*** This component is designed to measure the width of natural vegetation from the edge of the active channel landward onto the floodplain. The component consists of two columns; one rating the available floodplain and the other for percent covered by native vegetation. The evaluator should provide a score for each column and sum both scores for a total point value for the component. The vegetation type is not restricted to timber and may consist of trees, shrubs, grasses, forbs, hydrophytes or any combination these. The important aspect of the rating is to identify the quantity of the floodplain that consists of natural riparian vegetation, and which provides benefits such as streambank protection against erosion, dissipation of energy during flood events (thereby affecting the morphology and stability of the stream), water quality benefits to surface runoff and instream water quality, aquatic habitat and nutrient input to the stream, and habitat to terrestrial species that may in turn provide resources to the aquatic community (i.e. terrestrial insects). The land use can be grazed or ungrazed rangeland, pastures, woodlands, wetlands or other areas that contain native vegetation. Some exceptions to the vegetation being native in origin may exist. For example, a floodplain seeded to non-native brome that has not been grazed for a period of time may provide excellent protection against bank erosion and benefit water quality. The component is not designed to assess any benefits to terrestrial wildlife habitat. **The quality of the riparian area will be incorporated into the assessment when evaluating the floodplain land use component (B, #3)**. The evaluator should first determine the width of the floodplain, and then estimate the percentage of the floodplain that is composed of native vegetation. Keep in mind that streams are dynamic

systems where channel movement and valley flooding are regular natural behaviors and there may be several abandoned floodplains scattered throughout the stream valley. The floodplain to be measured is the area next to a stream, constructed by the river in the present climate and inundated at times of high discharge above bankfull height (Alan, 1995). Refer to the figure below.



The floodplain size and percentage that consists of native vegetation may vary significantly throughout a stream reach. The evaluator should provide an estimate of the entire reach when estimating the value. Many streams in Kansas have downcut (incised) and cannot access their floodplains. In these situations the floodplain has been abandoned and the stream is in a transitional state, trying to reform a floodplain within the incised channel. The abandoned floodplain and riparian vegetation should not be included when assessing this component of the key (refer to figure below); however, riparian vegetation adjacent to incised channels should be evaluated on terrestrial habitat evaluations.



2. ***Canopy Cover*** - Canopy cover is important in thermal regulation of stream temperatures, habitat for terrestrial fauna, and providing organic inputs important as foraging material for stream biota. Optimal canopy densities (i.e. 50 – 75%) provide these benefits, while continuing to allow for sunlight penetration to drive primary production within the stream. Professional judgement should be used to estimate canopy densities during periods when foliage is absent.

3. ***Floodplain Land Uses* -** The quality of the floodplain should be estimated by considering the land use and management for the area. Degradation of the ecological condition of running waters is common in areas that have a significant amount of human interference (Alan, 1995). Alteration to floodplain vegetation through agricultural and livestock activities has been a common concern for degradation of streams in Kansas; however, disturbance due to urban sprawl has escalated in recent decades and represents a serious concern for the health and

integrity of Kansas's streams. Evaluators should determine which component most accurately describes the land use type from within the floodplain (see above descriptions for identification of floodplain).

4. ***Watershed Land Uses*** - Land use within a watershed can alter stream flow magnitude and timing, leading to changes in channel characteristics and stability indices (Rosgen, 1996). Poorly implemented agricultural activities and human settlement are the two most influential factors that lead to stream degradation in a watershed. When determining land uses, the watershed to be evaluated should start at the downstream point of the project's impact area and extend upwards through all adjacent tributaries. For small ephemeral drainages this may only be a few acres, while for perennial streams the area could constitute hundreds or thousands of acres. The evaluator's knowledge of land use in the area and consultation with aerial photographs and other pertinent information will assist in scoring this component.

Land uses have been divided into categories:
1. Minimal impact: land uses, either through intentional design or the result of inadvertent land management, that have a minimal effect on the ecological function of the stream including parameters such as water quality, hydrology, nutrient input, habitat features, etc.

2. Significant impact: land use, either through intentional design or the result of inadvertent land management, that have a significant negative effect on the ecological function of the stream including parameters such as water quality, hydrology, nutrient input, habitat features, etc.

The evaluator should determine the commonality of these land uses in the upstream watershed, score both the minimal and significant impacts, sum the scores and provide a composite score for the parameter. Disputes on the land use component can be determined by having the project sponsor provide upstream land use percentages the extent of known conservation practices in place. This information can be obtained through the local USDA-NRCS office.

<u>The maximum point values for the watershed land use component should not exceed ±5 points</u>

C. Biological Component Key

The biological component key should evaluate the fish and invertebrate communities present in systems with adequate hydrology. If the reach is dry or adequate water is absent to support a biological component's community (fish/invertebrates/mussels, etc.), the biological component should <u>not</u> be incorporated into the final assessment habitat value (R). The evaluator should mark which components are not applicable. <u>Since the maximum value for the biological component is 15 points the evaluator should subtract these components from the total points possible to determine the final R-value.</u>

1. ***Fish Community*** - Assessing fish communities has been central in determining the ecological condition of streams (Karr, 1991). The number of species (richness) and their percentage of abundance in the community (relative abundance) are two key parameters that assist in determining the condition of the stream. There are several factors that influence species richness and relative abundance in a stream. Physical habitat features, variable climatic conditions, flow characteristics, inter- and intra-specific competition, and water quality can influence community structure. For example, fish communities from intermittent streams should not be evaluated in the same manner as perennial systems due to the influence of variable flow regimes on the migration patterns and survivorship of certain species. Typically, streams that maintain perennial flow are larger and provide more spatial area and habitat

diversity, thereby, lending them to be more diverse biologically (Alan, 1995). However, even ephemeral drainages can be colonized by fish species during periods of extended precipitation in a watershed, thereby providing certain species refuge from predators and forage resources that may have been depleted in downstream reaches. ***The evaluator should consider the type of habitat and hydrological regime for the area and determine if the fish community present is representative of the potential fish community that could be supported by that stream reach***. Higher point values are awarded to fish communities representative of endemic composition based on historical data. Other factors may influence the evaluators score as well. For example, an evaluator samples an intermittent stream's pool and finds it to be dominated by four species of cyprinids, but only a few individuals in three of the four species are present. In addition, there are numerous young green sunfish and largemouth bass in the pool, along with a few adults. The evaluator determines that a nearby watershed structure is likely influencing the relative abundance of the cyprinids by introducing a high number of predators into the watershed. The evaluator determines that the community is similar to historic collections in species richness, but not in relative abundance (points = 5 or 6).

In many small, shallow intermittent streams, fish communities may consist primarily of a few species capable of bypassing downstream fish barriers (i.e. low-water crossings, culverts, etc. These species are often strong benthic swimmers (i.e. Central Stoneroller, Southern Redbelly Dace AND/OR darter species (*Ethostoma spp.*)). Other streams may be dominated by early colonizing species (i.e. Red shiner, Bluntnose minnow, and aforementioned species) following the return of sustained flows to intermittent streams or after a period of water quality degradation has passed. Often in these instances, these native fishes may be found along with low to moderate numbers of sportfish (primarily Centrarchids) typically entering the system from upstream impoundments. In either of these circumstances, the evaluator may find these communities are dominated by native fishes in relative abundance and/or species richness; however, the community is often not indicative of the historical diversity that was likely present. Fish communities such as this are most-likely being influenced by anthropogenic effects such as in-channel structures (fish barriers, dams, etc.) and/or periods of water quality impairment.

The effect of alien or exotic species on native biota typically results in a decline in endemic species richness (Ross, 1991). Introduced species may have few predators or environmental limitations in their introduced habitats, leaving them capable of seriously impacting native fauna. Introduction of exotic species are particularly devastating due to the fact that, unlike chemical pollutants or habitat destruction, the effects of exotic species are virtually impossible to correct. Introduced species can alter habitat conditions, change trophic and spatial interactions, introduce disease, and hybridize with native species (Taylor et al., 1984), and once established, they often are capable of reproducing and dispersing far beyond the point of origin (Alan, 1995). The evaluator should consider not only introductions of species exotic to the region (carp, mosquito fish), but also the transplantation and unnatural proliferation of indigenous species into locales where they historically were absent or present only in substantially reduced numbers (i.e. largemouth bass, fathead minnow, golden shiners, etc.).

Distinctions among species tolerance to abiotic and biotic extremes often can dictate the richness and relative abundance of a fish community. Species more tolerant to high temperatures, poor water quality conditions, and reduced flows, may dominate community structure in areas that humans have significantly impacted. Evaluators should consider the anthropogenic effects on the watershed when determining whether tolerant species are more abundant than their historical relative abundance and richness would indicate. **Consult Table 1 and Figure 1** to help ascertain tolerance levels and introduced status of typical Kansas fishes.

2. ***Benthic aquatic invertebrates* -** Assessment of aquatic invertebrates is commonly used to evaluate the ecological health of streams. The presence of species intolerant to poor water quality conditions is often a good indicator of healthy stream conditions (Newton et al., 1998). A

thorough evaluation of substrate material in various habitat types (riffles, pools, runs) will provide sufficient indication of the aquatic invertebrate taxa. Evaluators should consider recent hydrologic fluctuations and life cycle characterizes of invertebrates to include colonization and emigration variables into the evaluation. Consultation of USDA/NRCS Technical Note 99-1 for specific information on Group I, II, and III taxa is provided in **Attachment I**.

3. ***Freshwater mussels*** - Freshwater mussels are also considered a good indicator of stream ecology, particularly of water quality conditions. Although much of Kansas's native mussel fauna has been adversely impacted by anthropogenic effects, many perennial streams and larger rivers continue to support healthy, reproductive populations of benthic bivalves. Evaluators should consider the flow regime of the stream under evaluation to determine if suitable hydrologic conditions exist to support mussel populations. Typically mussels will only be found in perennial streams, although intermittent streams with permanent pools may hold low numbers of these species. Only live or recently dead individuals should be included (no weathered or relic shells). Often live specimens can be seen in the shallows off point bars. A single point is added for this component strictly based on the presence or absence of live or recently dead individuals. Often this component will be 'not applicable' due to the large amount of upper headwater tributaries this assessment is used to evaluate; however, if a site has suitable pools and other habitat that could support mussel populations, but if no evidence exists to document their presence, a score of '0' should be provided.

4 – 5. ***Amphibian and Other Aquatic Vertebrates*** - Amphibians, reptiles, birds, and mammals are often part of the aquatic community in lotic systems and may have a significant role as predators on fish and invertebrate populations or as herbivores in the case of tadpoles (Allan, 1995). The component refers to species that require water for breeding and rearing areas, and/or those that typically spend a majority of their life stages in or near water. Some examples are Amphibians: all salamanders, frogs and toads; Reptiles: water snakes (Colubridae), softshell turtles (Trionychidae) aquatic basking turtles like the painted and map turtles, river Cooter and red-eared slider (Emydidae), and the mud and musk turtles (Kinosterniedae); Birds: kingfishers (Alcedinidae) and herons (Ardeidae); Mammals: beavers (Castoridae), muskrat, raccoon (Procyonidae), and mink (Mustelidae). Known or assumed presence/absence is used as criteria for the evaluation of these creatures due to the limitations they present to actually witnessing them (i.e. periods of dormancy for poikilotherms, nocturnalism, life history characteristics, etc.), although most can be identified by searching for tracks, wading the stream, or walking through stream-side vegetation. In cases where degraded sites are severely limiting or preventing these components a score of '0' should be provided.

D. Water Quality Component Key

Water quality components affect a stream's ability to support aquatic life. Five main parameters have been selected for the evaluator to assess based upon the effects degradation of these components can have on aquatic organisms; however, if it is determined other parameters are influencing aquatic life, those should be included along with a narrative description identifying their importance. The evaluator should determine if the parameter is frequently, occasionally, or rarely limiting aquatic life in the stream. Best professional judgement should be used when making this determination. For instance, if a stream appears to have an elevated amount of nutrient loading from upstream livestock or agricultural operations it would be prudent to assume oxygen supply may be limiting. Nutrient enrichment may be identified from algae mats in stream reaches with available sunlight penetration through the canopy. The evaluator should determine the influence of pesticides from adjacent and upstream land uses through their familiarity with the agricultural practices of the watershed. Turbidity may be detrimental if excessive sediments are suspended in the water column or if persistent plankton blooms inhibit visibility. Temperature is typically considered limiting when elevated due to anthropogenic effects such as runoff from streets and parking lots, concrete lined sections of streams, elimination of overhead canopy, etc. As with the biological key, if the reach is dry, the water quality component should not be incorporated into the final assessment habitat value (R). Since the maximum value for the water quality component is 15 points the evaluator should subtract this from the total points possible to determine the final R-value.

Aquatic habitat summary sheet:

This form summarizes the results from the key and allows the evaluator to provide some data on physical characteristics of the stream, species observed during the evaluation, and any comments related to the implementation of the project that should be incorporated in an environmental review. It may also be used to provide space for narrative descriptions regarding specific components that the evaluator modified when scoring. Information on linear feet can be either estimated from maps (aerial photographs/topographic) or measured with the use of GIS or GPS.

Procedures

STEP 1: Sufficiently examine the entire stream reach within the evaluation area to document the components shown on the field key. Some sampling may be necessary to determine the biological components. Existing data on file can be used, but collection of empirical site data is preferred whenever possible. Record all pertinent data and site information on the field form provided.

STEP 2: Using the field key, determine the appropriate component values and calculate.

Stream Name:______________________________Co.:________File #D1.0402 Track #:____________

Legal Description: ___________/4_____Sec. _________Twp. ________S, Range.___________E / W Date:________

WJD: ______________________________Site #:_____________Reviewed By:_________________________

USE BEST PROFESSIONAL JUDGEMENT TO PROVIDE THE MOST APPROPRIATE POINT VALUE FOR EACH COMPONENT ASSESSED

A. PHYSICAL HABITAT KEY (10 COMPONENTS)

1. Stream Type

Perennial	9 or 10
Intermittent w/perm pools (springs/subterranean flow)	6 or 7 or 8
Intermittent (no permanent pools)	3 or 4 or 5
Ephemeral	1 or 2

SCORE:

2. Substrate (circle the 2 predominant types and average the score)

Boulder/Cobble (>3.0")	5
Gravel (pea sized to tennis ball) (>0.1" but <3.0")	4
Sand/Leaf litter	3
Mud/Detritus/Muck	2
Bedrock	1

AVG. SCORE:

3. Number of Substrate Types

5 or more w/gravel, cobble, or boulder	5
3 - 4 types present	3 or 4
2 or fewer types present	1 or 2

SCORE:

4. Percent Embeddedness

Light (<20%)	2
Moderate (20 - 40%)	1
Elevated (40 - 60%)	-1
Heavy (>60%)	-2

SCORE:

5. Sinuosity (channel length ÷ valley length)

Highly sinuous (at least > 1.5)	3
Moderate (1.2 – 1.5)	2
Low sinuosity (1.0 – 1.2)	1
Straightened channel	0

SCORE:

6. Pool-Riffle sequencing

Stable channel (pool & riffle complex every 10-14 bankfull widths)	3
Sequencing indicates instability (< or > 10-14 bankfull widths):	0 or 1 or 2

SCORE:

7. Bank Erosion (Average score for both banks)

L	R	Little or none	4 or 5
L	R	Moderate	2 or 3
L	R	Severe	0 or 1

AVG. SCORE:

8. Instream Cover Types (circle all that apply and total the score)

Deep pools	1 or 2	Riffles	1 or 2
Logs or large woody debris	1	Rootwads	1
Backwaters or oxbows	1	Boulders	1
Overhanging vegetation	1	Undercut banks	1
Vegetated shallows	1	Side channel pools	1

SCORE:

***9. Amount of Instream Cover* (% of active channel)**

Extensive > 75%	5
Abundant 50 - 75%	4
Moderate 25 - 50%	3
Sparse 10 - 25%	2
Little or none 0 - 10%	1

SCORE:

***10. Channel Modifications* (Consider the following and estimate impact)**

Concrete lining, channelization, fish barriers, up/downstream impoundments, riparian clearing, floodplain restriction (dikes/levees), dredging, riprap/gabion baskets, other

No impact = 0; Slight to moderate = -1 or -2; Significant to Entire = -3 or -4 or -5

TOTAL FOR PHYSICAL HABITAT COMPONENTS (50 max) =

B. RIPARIAN/FLOODPLAIN/LAND USE KEY (4 COMPONENTS)

1. *Riparian floodplain condition*

Percent	% of historical floodplain available for inundation	% Covered by native vegetation
> 90	5	5
70 – 90	4	4
50 – 70	3	3
25 – 50	2	2
5 -25	1	1
< 5 or none	0	0

SCORE: Add points for both columns and record here:_________

***2. Canopy Cover* (% of water shaded with the sun directly overhead)**

50 - 75%	2
25- 50% or 75 - 90%	1
< 25% or > 90%	0

SCORE:

***3. Floodplain Land Uses* (Provide a composite score for both banks)**

			Points
L	R	Ungrazed native vegetation (i.e. woodlands, native grass, wetlands)	+3
L	R	Good grazing practices on native woodland, wetland, or native grass	+2
L	R	Good grazing or haying on domestic grass pasture, cropland with excellent conservation practices	+1
L	R	Poor grazing practices on native or domestic pastures, cropland w/good conservation practices	-1
L	R	Cropland w/poor conservation practices	-2
L	R	Urban/industrial or no available floodplain	-3
L	R	Other	Provide score

SCORE:

***4. Watershed Land Uses* (Describe the extent of land use in the upstream watershed)**

A. Minimal impact land uses: Ungrazed native vegetation (i.e. woodlands, native grass, wetlands), good grazing practices, cropland w/good to excellent conservation practices.

None = 0   Sparse = + 1   Moderate = + 2   Common = + 3   Abundant = + 4   Entire = + 5

B. Significant impact land uses: Poor grazing practices, cropland w/ fair to poor conservation practices, urban/industrial/commercial/residential.

None = 0   Sparse = - 1   Moderate = - 2   Common = - 3   Abundant = - 4   Entire = - 5

Other ____

SCORE (**MAX: + or – 5 points**):

TOTAL FOR RIPARIAN/FLOODPLAIN/LAND USE COMPONENTS (20 max) =

C. BIOLOGICAL COMPONENT KEY (5 COMPONENTS - if stream is dry & component is not applicable, do not include in final R-value)

1. Fish Community Characteristics ______**check here if NOT APPLICABLE**

Resembles native fish community in species richness and relative abundance exotic species rare to absent	7
Resembles native fish community in species richness but not relative abundance, exotic species present in low numbers	5 or 6
Community diversity significantly lower than the potential, species may be indicative of early colonizers or species capable of bypassing fish barriers, often intermixed with low numbers of impoundment escapee fishes	3 or 4
Community dominated by exotic and/or tolerant species	1 or 2
No fish present, but flow is adequate to support populations	0

SCORE:

2. Benthic Aquatic Invertebrates ______**check here if NOT APPLICABLE**

Group I taxa common or abundant (stone, caddis, mayflies, hellgrammite, gilled snail, riffle beetle)	5
Group II dominant taxa (crayfish, damsel & dragonflies, various coleoptera, alderfly)	3 or 4
Group III dominant taxa (oligocheates, midge, blackfly, leech, other gastropods)	1 or 2
None present, but flow adequate to support populations	0

SCORE:

Provide 0 or +1, if not applicable do not include in final score

***3. Freshwater mussels* (live or recently dead)**	N/A	0 or +1
***4. Amphibians* (frogs/toads/salamanders)**	N/A	0 or +1
***5. Other aquatic vertebrates* (i.e. aquatic or semi-aquatic mammals/reptiles/birds)**	N/A	0 or +1

TOTAL FOR BIOLOGICAL COMPONENTS (15 max*) =

(*FOR COMPONENTS CONSIDERED N/A - subtract points N/A from total points possible and record in the TOTAL SCORE table below)

D. WATER QUALITY COMPONENT KEY (if stream is dry and/or component is not applicable, do not include in final R-value)

Water Quality Parameters	Frequently Limiting	Occasionally Limiting	Rarely Limiting	Not Applicable
DO/BOD	0	1 or 2	3	N/A
Nutrient enrichment	0	1 or 2	3	N/A
Pesticides	0	1 or 2	3	N/A
Turbidity	0	1 or 2	3	N/A
Temperature	0	1 or 2	3	N/A
Other				

TOTAL FOR WATER QUALITY COMPONENTS (15 max*) =

(*FOR COMPONENTS CONSIDERED N/A - subtract points N/A from total points possible and record in the TOTAL SCORE table below)

TOTAL SCORE = Physical + Riparian + Biological + Water quality

Component	Points Possible	Points Scored
Physical	50	
Riparian/Floodplain/Land Use	20	
Biological (15 max)		
Water Quality (15 max)		
Total =		

R-Value = (Points Scored ÷ Points Possible) X 10 =

EXCELLENT = 8.0 - 10.0; GOOD = 5.6 - 7.9; FAIR = 3.1 - 5.5; POOR = 1.0 - 3.0

Kansas Department of Wildlife and Parks

File No. D1.0402

Aquatic Habitat Summary

Track #__________________

Watershed District:_______________________________________Site No.____________

Date:___________________County:______Evaluator (s):________________________________

___________/4 Sec:_________ Twp:_______________ Rge:_________

Habitat Types Impacted	R-Value	Impact area	Estimated?	Measured?
Stream		Linear feet =		
Impoundment		Acres =		

STREAM CHARACTERISTICS (if applicable):

Volume of flow: _____________cfs Velocity: average: __________________ft/s

Mean depth:__________ ft (minimum: _________ft; max:________ ft)

Mean width: __________(minimum: __________ft; max:________ ft)

FISH - check method: ____ seining; ____ dip-net; ____ electrofishing

____

____

____

____

MUSSELS/BENTHIC INVERTEBRATES:

____

____

AMPHIBIANS AND OTHER AQUATIC/SEMI-AQUATIC VERTEBRATES

____

____

T/E/SINC SPECIES KNOWN OR LIKELY TO OCCUR (review county lists if necessary):

____

____

PROJECT COMMENTS: List alternatives possible to accomplish project goals and lessen adverse impacts on habitat removal or destruction:

____

____

____

____

____

IMPOUNDMENT EVALUATION

The overwhelming majority of impoundments in Kansas are man-made structures used for water supply, recreational, agricultural, or flood-control and grade stabilization purposes. These structures provide a number of benefits to wildlife adapted to lentic habitat types. The impoundment evaluation is designed to provide a qualitative assessment of the habitat available to these species, as well as water quality conditions. The assessment, as with the stream assessment, incorporates geological and morphological habitat characteristics, riparian and watershed condition, biological components, and water chemistry into the protocol. By merging these variable characteristics of an impoundment into a single subjective assessment we can rapidly produce a quality determination of the habitat characteristics and ecological condition through a single site visit.

Several components differ in the evaluation of impoundments versus streams.

A. PHYSICAL HABITAT KEY

1. ***Shoreline Development*** **–** The Shoreline Development Index (SDI) is a common morphometric measurement used to calculate the amount of littoral zone present on a water body (McMahon et al., 1996). The littoral zone of a water body provides spawning and nursery habitat for the majority of lentic fish species, as well as being the area of greatest biological productivity and habitat use by other aquatic and semi-aquatic wildlife. The SDI incorporates the area of the impoundment and shoreline length, and is calculated from the following equation:

$$SDI = \frac{L}{(2)\sqrt{A\pi}}$$

Where L = shoreline length (feet) and A = surface area of the impoundment (acres). For purposes of this assessment, we have provided a simpler method for estimating the SDI value. The evaluator should estimate the ratio of the shoreline length compared to that of an impoundment of equal area shaped as a circle. A circular shaped impoundment would have an SDI of 1, offering the minimal amount of littoral zone compared to the surface area of the water body. The following table may help in estimating SDI values:

Surface Acres	Shoreline Length (appx. ft)	SDI
1	740	1
1	1480	2
1	2220	3
3	1280	1
3	2560	2
3	3840	3
10	2340	1
10	4680	2
10	7020	3

So for example, if an evaluator is determining the shoreline development of a 3 acre impoundment and estimates the shoreline length at approximately 2,000 feet, this would constitute a ratio of approximately 1.6:1 (2,000 ÷ 1,280), providing a component score of 5. Calculations can be documented in section 'E' of the impoundment key.

2. ***Average Depth*** – Average depth of the impoundment can be estimated with the use of a weighted bobber with incremental depths identified, from individuals familiar with the impoundment (i.e. landowners, watershed district managers, etc.), or by actually measuring the depth with a depth stick. Increased average depth provides critical refuge during winter months for numerous fish species, habitat for various aquatic species that prefer deep water areas, and is critical in the lake stratification and turnover process.

3. ***Annual Storage Ratio*** – The annual storage ratio is a hydrodynamic variable commonly used to describe the rate at which water moves through an impoundment (McMahon et al., 1996). It is synonymous with other calculations such as flushing rate and turnover time, which describe water transport through impoundments. Storage ratio is measured as:

$$\text{Storage Ratio} = \frac{\text{Storage volume (Acre feet)}}{\text{Annual discharge rate (Acre feet)}}$$

For example, if the evaluator is calculating the storage ratio for the 3 acre impoundment listed above, and it is estimated the average depth is 5 feet, the impoundment would have a storage volume of 15 acre feet. If the average annual discharge is estimated at 0.01 CFS (approximately 5 gallons/minute) the annual discharge rate could be calculated as:

$$\frac{0.01\,\text{cubic feet}}{\text{sec}} * \frac{60\,\text{sec}}{\text{min}} * \frac{60\,\text{min}}{\text{hr}} * \frac{24\,\text{hr}}{\text{day}} * \frac{365\,\text{day}}{\text{year}} * \frac{1\,\text{acre foot}}{43{,}560\,\text{cubic feet}} = 7.2\,\text{acre feet}$$

Thus, storage ratio would be equal to 2.1 (15 ÷ 7.2) and would receive a score of ‘3’ on the evaluation form. In Kansas, reservoirs with storage ratios less than 1 produced lower densities of fish than those with moderate storage ratios (1-2), and reservoirs with higher storage ratios (>2.0) had slightly lower densities than those with moderate storage ratios, indicating there is an optimal rate of water movement through an impoundment that reduces the number of fish lost through discharge events (Willis and Stephen, 1987)

The following table will help describe discharge amounts when estimating storage ratio:

Average discharge Gallons/minute	CFS	Annual discharge rate (acre feet)
4.5------------------------------→	0.01	7.2
45-------------------------------→	0.1	72
450-----------------------------→	1	720

4 – 6. **Substrate, Number of Substrate Types, and Amount of Cover** – As pointed out in the stream evaluation guidelines, substrate diversity is correlated to biological diversity and is an important habitat characteristic. When estimating the amount of cover for component #6 (Amount of Cover) the percentage of available cover should be estimated from the littoral zone, not the water body as a whole.

7. ***Native Vegetative Buffer*** - Native vegetation adjacent to the water body provides similar benefits to an impoundment as a does a riparian zone along a stream. Benefits include protection against bank erosion, water quality benefits to surface runoff, aquatic habitat and nutrient input to the impoundment, and habitat to terrestrial species that may in turn provide resources to the aquatic community (i.e. terrestrial insects).

8. ***Bank erosion*** – Erosion of banks through sloughing from wave action and livestock trampling and degrade water quality and habitat for aquatic species, and decrease the sediment storage for the impoundment.

B. WATERSHED LAND USE AND IMPOUNDMENT MANAGEMENT

1. ***Impoundment Management*** – Various strategies can be implemented to provide benefits to the aquatic habitat of an impoundment. Drawdowns in water elevation allows for areas in the littoral zone that are typically inundated to colonize with vegetation and invertebrates, thus providing excellent food resources and nursery habitat for fish species following subsequent inundation. Management of water levels can be implemented with draw-down valves and can be coupled with flow-augmentation for the downstream channel, thus reducing de-watering effects downstream. Fish fences around spillways prevent the escape of impoundment fishes and reduce their influence on stream fish communities. Excluding livestock from the impoundment will improve water quality and protect banks from trampling effects. Fish feeders can increase growth and vigor of many sport fishes, and along with supplemental stockings and managed harvest rates, the quality of the fishery can be improved and overpopulation and growth stunting reduced. Other management strategies that maintain a quality sport fishery such as following strict harvest guidelines for large predators (i.e. Largemouth Bass, Wipers, ect.) and preventing the introduction of nuisance fish (i.e. Bullheads, Green sunfish, in some cases Crappie, etc.) should be awarded points when applicable.

2. ***Watershed Land Uses*** **-** Poorly implemented agricultural activities and human settlement are the two most influential factors that lead to degradation of an impoundment primarily by increasing sedimentation and degrading water quality. The evaluator should estimate the extent of minimal and significant impact land uses in the upstream watershed, as described in the stream evaluation guidelines, and provide the appropriate points. The maximum point values to be added are +/- 5 points.

C. BIOLOGICAL COMPONENT

1. ***Fishery Characteristics*** – Impoundments are virtually all man-made structures in Kansas, and as such, their fishery components typically consist of sport fishes stocked for recreational purposes. This fact is recognized in this component, and provides a higher habitat value to an impoundment that provides high-quality recreational fishing opportunities. In addition, most high-quality sport fisheries are an indication of a well-managed facility and upstream watershed, and can be considered an indicator of overall biological health for the aquatic community. Occasionally, exotic fish may be a detriment to the fishery potential of an impoundment such as the case with the White Perch (*Morone americana*). In these instances, the evaluator may deduct 5 points for this component. The negative aspects of impoundments on native stream fish communities are not considered in this component, but are addressed in the stream evaluation.

2. ***Aquatic Insects*** – Aquatic insects are imperative to the overall aquatic community of lentic systems. Since most aquatic insects native to Kansas evolved in streams, much of the habitat these organisms require does not exist in impoundments; therefore, many of the macroinvertebrates listed in the aquatic insect component for the stream evaluation may not exist in impoundments. This component addresses species richness (i.e. number) of phylogenetic Orders of macroinvertebrates, rather than the presence/absence of species

indicative of anthropogenic effects (habitat destruction, water quality impairment, etc.). Consult **ATTACHMENT I for assistance categorizing benthic macroinvertebrates**.

3 – 4. ***Mollusc/Crayfish and Other Aquatic and Semi-Aquatic Vertebrates*** **–** These two components provide an estimation of various aquatic and semi-aquatic organisms that may exist in impoundments. As with aquatic insects, most of these organisms evolved in streams, and the majority of species that exist in impoundments evolved in lentic habitat types that exist in slow-moving streams, back-water oxbows, or wetlands. The evaluator should account for live or recently dead individuals to estimate existing populations for mussels and crayfish. Since the introduction of Zebra mussels (*Dreissena polymorpha*) to Kansas in 2003, evaluators should check for the presence of these organisms in the impoundment and deduct 5 points from the score if present. Other aquatic vertebrates may include amphibians, reptiles, birds, and mammals that live or breed in or near impoundments.

D. WATER QUALITY COMPONENT KEY

Water quality will affect an impoundment's ability to support aquatic life. As with the steam assessment, five main parameters have been selected for the evaluator to assess based upon the effects degradation of these components can have on aquatic organisms; however, if it is determined other parameters are influencing aquatic life, those should be included along with a narrative description identifying their importance. The evaluator should determine if the parameter is frequently, occasionally, or rarely limiting aquatic life in the stream. Best professional judgement should be used when making this determination.

E. IMPOUNDMENT CHARACTERISTICS, PROJECT COMMENTS, AND SPECIES INFORMATION

This section is not included in the qualitative score for the impoundment, but rather allows the evaluator to provide some data on physical characteristics of the water body, species observed during the evaluation, and any comments related to the implementation of the project that should be incorporated in an environmental review. It may also be used to provide space for narrative descriptions regarding specific components that the evaluator modified when scoring.

File: ______________
____
____
Track: ______________

KANSAS DEPARTMENT OF WILDLIFE & PARKS
IMPOUNDMENT HABITAT EVALUATION

Impoundment Name:_______________________________ Co.:______________
Legal Description: ________/________ Sec. ________, Twp. ________ S, Range.________ E / W
Reviewed By: ______________________________________ Date: _______________________

Circle one: Pond (≤ 5 acres) Lake (> 5 < 500 acres) Reservoir (>500 acres) Est. acreage:__________

A. Physical Habitat Key

1. Shoreline development (perimeter of impoundment ÷ perimeter of circle of equal area)

	Points
High ≥ 2.5	6 - 10
Medium 1.5 – 2.4	3 - 5
Low 1.0 – 1.4	1 - 2

2. Average Depth

	Points
> 10 feet	6 - 10
3 – 10	3 - 5
< 3	1 - 2

3. Annual Storage Ratio

	Points
1 – 2	5
> 2	3 - 4
< 1	1 - 2

4. Substrate (select two predominant types in littoral zone and average the score)

	Points
Boulder/Cobble (>3.0")	5
Gravel (>0.1" but < 3.0")	4
Sand (<0.1")	3
Bedrock	2
Mud/Detritus/Muck	1

5. Number of substrate types in littoral zone

	Points
4 or more w/gravel/cobble/boulder	5
3 types present	3 - 4
2 types present	2
1 type present	1

6. Amount of cover (aquatic vegetation, flooded timber, woody debris, large boulders, rock outcrops, overhanging vegetation, man-made structures)

% of littoral zone	Points
Extensive (>75%)	9 - 10
Abundant (50 0 75%)	7 - 8
Moderate (25 – 50%)	5 - 6
Sparse (5 – 25%)	3 - 4
Little or none (0 – 5%)	1 - 2

7. Native vegetation buffer

	Points
> 50 meters	5
10 – 50 meters	4
5 – 10 meters	3
1 – 5 meters	1 - 2
none	0

8. Bank erosion

	Points
Stable banks w/little sloughing	4 - 5
Moderate erosion due to livestock trampling &/or wave action	2 - 3
Severe active erosion along banks	0 - 1

Total for the physical habitat components (max 55) =

B. Watershed land use and management key

1. Management strategies

	Points
Fish fences	+1
Livestock exclusion	+1
Drawdowns	+1
Downstream flow augmentation	+1
Fish feeders	+1
Other (i.e. harvest restrictions, nuisance species control, etc) =	

Total =

2. ***Watershed Land Uses*** ***(Describe the extent of land use in the upstream watershed)***

A. Minimal impact land uses: Ungrazed native vegetation (i.e. woodlands, native grass, wetlands), good grazing practices, cropland w/good to excellent conservation practices.
None = 0 Sparse = + 1 Moderate = + 2 Common = + 3
Abundant = + 4 Entire = + 5
B. Significant impact land uses: Poor grazing practices, cropland w/ fair to poor conservation practices, urban, industrial, commercial, residential.

None = 0 Sparse = - 1 Moderate = - 2 Common = - 3
Abundant = - 4 Entire = - 5

SCORE (**MAX: + or – 5 points**):

Total for the watershed/management components (max 10) =

C. Biological Component Key

1. Fishery Characteristics

	Points
High quality sport fishery	9 - 10
Pan & predaceous	7 - 8
Minnows/panfish/roughfish	3 - 6
Minnows/roughfish	1 - 2
No fish	0
Problem or exotic fish dominant	-5

2. Aquatic Insects

	Points
> 3 orders present	4 - 5
1 – 3 orders present	1 - 3
None	0

3. Mollusc/Crayfish

	Points
Common/Abundant	2 - 3
Sparse	1
None	0
Zebra mussels present	-5

4. Other aquatic/semi-aquatic vertebrates

	Points
Common/Abundant	2
Sparse	1
None	0

Total for the biological components (max 20) =

D. Water Quality Component Key

Water Quality Parameters	**Frequently Limiting**	**Occasionally Limiting**	**Rarely Limiting**
DO/BOD	0	1 – 2	3
Nutrient enrichment	0	1 – 2	3
Pesticides	0	1 – 2	3
Turbidity	0	1 – 2	3
Temperature	0	1 – 2	3
Other (list if applicable)			

Total for water quality component (15 max) =

TOTAL SCORE

$$= \frac{\text{Physical + Watershed/Management+ Biological + Water Quality}}{10}$$

R =

E. Impoundment Characteristics (attach to aquatic habitat summary):

Watershed Area = ______________________ Shoreline Perimeter = ___________________________

Impoundment Area = ____________________ SDI (shoreline dev. Ratio) = ______________________
(permanent pool)

Project Comments: alternatives possible to accomplish project goals & lessen adverse impacts on habitat

FISH – if sampled check method: ____ seining; ____ dip-net; ____ electrofishing

Species

OTHER AQUATIC/SEMI-AQUATIC VERTEBRATES:

MUSSELS:

T/E SPECIES KNOWN/LIKELY TO OCCUR:

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Table 1. List of Kansas fish with tolerance values to anthropogenic stressors
S = Sensitive; I = Intermediate; T = Tolerant (Plafkin et al., 1989)

FISHNAME	GENUS	SPECIES	TOLERANCE	Introduced Species
LAKE STURGEON	ACIPENSER	FULVESCENS	S	
PALLID STURGEON	SCAPHIRHYNCHUS	ALBUS	I	
SHOVELNOSE STURGEON	SCAPHIRHYNCHUS	PLATORYNCHUS	S	
BOWFIN	AMIA	CALVA	T	
AMERICAN EEL	ANGUILLA	ROSTRADA	I	
BROOK SILVERSIDES	LABIDESTHES	SICCULUS	I	
INLAND SILVERSIDES	MENIDIA	BERYLLINA	I	X
RIVER CARPSUCKER	CARPIODES	CARPIO	T	
QUILLBACK	CARPIODES	CYPRINUS	I	X
HIGHFIN CARPSUCKER	CARPIODES	VELIFER	S	
WHITE SUCKER	CATOSTOMUS	COMMERSONI	I	
BLUE SUCKER	CYCLEPTUS	ELONGATUS	S	
NORTHERN HOG SUCKER	HYPENTELIUM	NIGRICANS	S	
SMALLMOUTH BUFFALO	ICTIOBUS	BUBALUS	I	
BIGMOUTH BUFFALO	ICTIOBUS	CYPRINELLUS	I	
BLACK BUFFALO	ICTIOBUS	NIGER	I	
SPOTTED SUCKER	MINYTREMA	MELANOPS	I	
RIVER REDHORSE	MOXOSTOMA	CARINATUM	S	
BLACK REDHORSE	MOXOSTOMA	DUQUESNEI	S	
GOLDEN REDHORSE	MOXOSTOMA	ERYTHRURUM	I	
SHORTHEAD REDHORSE	MOXOSTOMA	MACROLEPIDOTUM	I	
ROCK BASS	AMBLOPLITES	RUPESTRIS	S	X
GREEN SUNFISH	LEPOMIS	CYANELLUS	T	
WARMOUTH	LEPOMIS	GULOSUS	I	
ORANGESPOTTED SUNFISH	LEPOMIS	HUMILUS	T	
BLUEGILL	LEPOMIS	MACROCHIRUS	I	X (to Eco. 25, 26, 27)
LONGEAR SUNFISH	LEPOMIS	MEGALOTIS	S	
REDEAR SUNFISH	LEPOMIS	MICROLOPHUS	I	X
SMALLMOUTH BASS	MICROPTERUS	DOLOMIEU	I	
SPOTTED BASS	MICROPTERUS	PUNCTULATUS	I	
LARGEMOUTH BASS	MICROPTERUS	SALMOIDES	I	X (to Eco. 25,26,27)
WHITE CRAPPIE	POMOXIS	ANNULARIS	I	
BLACK CRAPPIE	POMOXIS	NIGROMACULATUS	I	X
SKIPJACK HERRING	ALOSA	CHRYSOCHLORIS	I	
GIZZARD SHAD	DOROSOMA	CEPEDIANUM	T	
THREADFIN SHAD	DOROSOMA	PETENSE	I	X
BANDED SCULPIN	COTTUS	CAROLINAE	I	
CENTRAL STONEROLLER	CAMPOSTOMA	ANOMALUM	I	
GOLDFISH	CARASSIUS	AURATUS	T	X
GRASS CARP	CTENOPHARYNGODON	IDELLA	I	X
BLUNTFACE SHINER	CYPRINELLA	CAMURA	S	
COMMON CARP	CYPRINUS	CARPIO	T	X
RED SHINER	CYPRINELLA	LUTRENSIS	T	
SPOTFIN SHINER	CYPRINELLA	SPILOPTERA	I	
GRAVEL CHUB	ERIMYSTAX	X-PUNCTATUS	S	
BIGEYE CHUB	HYBOPSIS	AMBLOPS	S	
WESTERN SILVERY MINNOW	HYBOGNATHUS	ARGYRITIS	S	
BRASSY MINNOW	HYBOGNATHUS	HANKINSONI	S	
PLAINS MINNOW	HYBOGNATHUS	PLACITUS	S	
CARDINAL SHINER	LUXILUS	CARDINALIS	S	

Table 1. List of Kansas fish with tolerance values to anthropogenic stressors
S = Sensitive; I = Intermediate; T = Tolerant (Plafkin et al., 1989)

FISHNAME	GENUS	SPECIES	TOLERANCE	Introduced Species
COMMON SHINER	LUXILUS	CORNUTUS	I	
REDFIN SHINER	LYTHRURUS	UMBRATILIS	I	
SPECKLED CHUB	MACRHYBOPSIS	AESTIVALIS	S	
STURGEON CHUB	MACRHYBOPSIS	GELIDA	S	
SICKLEFIN CHUB	MACRHYBOPSIS	MEEKI	S	
SILVER CHUB	MACRHYBOPSIS	STORERIANA	I	
REDSPOT CHUB	NOCOMIS	ASPER	S	
HORNYHEAD CHUB	NOCOMIS	BIGUTTATUS	S	
GOLDEN SHINER	NOTEMIGONUS	CRYSOLEUCAS	T	X (to Eco. 25,26,27)
EMERALD SHINER	NOTROPIS	ATHERINOIDES	I	
RED RIVER SHINER	NOTROPIS	BAIRDI	I	X
RIVER SHINER	NOTROPIS	BLENNIUS	I	
BIGEYE SHINER	NOTROPIS	BOOPS	S	
GHOST SHINER	NOTROPIS	BUCHANANI	I	
BIGMOUTH SHINER	NOTROPIS	DORSALIS	I	
ARKANSAS RIVER SHINER	NOTROPIS	GIRARDI	S	
BLACKNOSE SHINER	NOTROPIS	HETEROLEPIS	S	
OZARK MINNOW	NOTROPIS	NUBILUS	I	
ROSYFACE SHINER	NOTROPIS	RUBELLUS	S	
SILVERBAND SHINER	NOTROPIS	SHUMARDI	S	
SAND SHINER	NOTROPIS	STRAMINEUS	T	
TOPEKA SHINER	NOTROPIS	TOPEKA	S	
MIMIC SHINER	NOTROPIS	VOLUCELLUS	S	
PUGNOSE MINNOW	OPSOPOEODUS	EMILIAE	S	
SUCKERMOUTH MINNOW	PHENACOBIUS	MIRABILIS	T	
SOUTHERN REDBELLY DACE	PHOXINUS	ERYTHROGASTER	S	
BLUNTNOSE MINNOW	PIMEPHALES	NOTATUS	T	
FATHEAD MINNOW	PIMEPHALES	PROMELAS	T	
SLIM MINNOW	PIMEPHALES	TENELLUS	S	
BULLHEAD MINNOW	PIMEPHALES	VIGILAX	I	
FLATHEAD CHUB	PLATYGOBIO	GRACILIS	I	
BLACKNOSE DACE	RHINICHTHYS	ATRATULUS	T	
CREEK CHUB	SEMOTILUS	ATROMACULATUS	T	
NORTHERN STUDFISH	FUNDULUS	CATENATUS	I	
BLACKSTRIPE TOPMINNOW	FUNDULUS	NOTATUS	I	
PLAINS TOPMINNOW	FUNDULUS	SCIADICUS	I	
PLAINS KILLIFISH	FUNDULUS	ZEBRINUS	I	
NORTHERN PIKE	ESOX	LUCIUS	I	X
BURBOT	LOTA	LOTA	I	
GOLDEYE	HIODON	ALOSOIDES	I	
MOONEYE	HIODON	TERGESIS	S	
BLACK BULLHEAD	AMEIURUS	MELAS	T	
YELLOW BULLHEAD	AMEIURUS	NATALIS	T	
BROWN BULLHEAD	AMEIURUS	NEBULOSUS	I	X
BLUE CATFISH	ICTALURUS	FURCATUS	I	
CHANNEL CATFISH	ICTALURUS	PUNCTATUS	I	
SLENDER MADTOM	NOTURUS	EXILIS	S	
STONECAT	NOTURUS	FLAVUS	I	
TADPOLE MADTOM	NOTURUS	GYRINUS	I	
BRINDLED MADTOM	NOTURUS	MIURUS	S	
FRECKLED MADTOM	NOTURUS	NOCTURNUS	I	

Table 1. List of Kansas fish with tolerance values to anthropogenic stressors
S = Sensitive; I = Intermediate; T = Tolerant (Plafkin et al., 1989)

FISHNAME	GENUS	SPECIES	TOLERANCE	Introduced Species
NEOSHO MADTOM	*NOTURUS*	*PLACIDUS*	S	
FLATHEAD CATFISH	*PYLODICTIS*	*OLIVARIS*	I	
SPOTTED GAR	*LEPISOSTEUS*	*OCULATUS*	T	
LONGNOSE GAR	*LEPISOSTEUS*	*OSSEUS*	T	
SHORTNOSE GAR	*LEPISOSTEUS*	*PLATOSTOMUS*	T	
WHITE BASS	*MORONE*	*CHRYSOPS*	I	X (to Eco. 25, 26, 27)
STRIPED BASS	*MORONE*	*SAXATILUS*	I	X
GREENSIDE DARTER	*ETHEOSTOMA*	*BLENNIOIDES*	S	
BLUNTNOSE DARTER	*ETHEOSTOMA*	*CHLOROSOMUM*	S	
ARKANSAS DARTER	*ETHEOSTOMA*	*CRAGINI*	S	
FANTAIL DARTER	*ETHEOSTOMA*	*FLABELLARE*	I	
SLOUGH DARTER	*ETHEOSTOMA*	*GRACILE*	S	
LEAST DARTER	*ETHEOSTOMA*	*MICROPERCA*	I	
JOHNNY DARTER	*ETHEOSTOMA*	*NIGRUM*	I	
STIPPLED DARTER	*ETHEOSTOMA*	*PUNCTULATUM*	S	
ORANGETHROAT DARTER	*ETHEOSTOMA*	*SPECTABILE*	I	
SPECKLED DARTER	*ETHEOSTOMA*	*STIGMAEUM*	I	
REDFIN DARTER	*ETHEOSTOMA*	*WHIPPLEI*	I	
BANDED DARTER	*ETHEOSTOMA*	*ZONALE*	S	
LOGPERCH	*PERCINA*	*CAPRODES*	I	
CHANNEL DARTER	*PERCINA*	*COPELANDI*	S	
YELLOW PERCH	*PERCA*	*FLAVESCENS*	I	X
BLACKSIDE DARTER	*PERCINA*	*MACULATA*	S	
SLENDERHEAD DARTER	*PERCINA*	*PHOXOCEPHALA*	S	
RIVER DARTER	*PERCINA*	*SHUMARDI*	I	
SAUGER	*STIZOSTEDION*	*CANADENSE*	I	
WALLEYE	*STIZOSTEDION*	*VITREUM*	I	
CHESTNUT LAMPREY	*ICHTHYOMYZON*	*CASTANEUS*	S	
WESTERN MOSQUITOFISH	*GAMBUSIA*	*AFFINIS*	T	X
PADDLEFISH	*POLYODON*	*SPATHULA*	S	
RAINBOW TROUT	*ONCORHYNCHUS*	*MYKISS*	I	X
BROWN TROUT	*SALMO*	*TRUTTA*	I	X
FRESHWATER DRUM	*APLODINOTUS*	*GRUNNIENS*	I	
WHITE PERCH	*MORONE*	*AMERICANA*	I	X
RUDD	*SCARDINIUS*	*ERYTHROPHTHALMUS*		X
WIPER		*MORONE*		X
SAUGEYE		*STIZOSTEDION*		X
BIGHEAD CARP	*HYPOPHTHALMICHTHYS*	*NOBILIS*		X
RED RIVER PUPFISH		*CYPRINODON*		X
PEPPERED CHUB	*MACRHYBOPSIS*	*TETRANEMA*		
RAINBOW SMELT	*OSMERUS*	*MORDAX*		X

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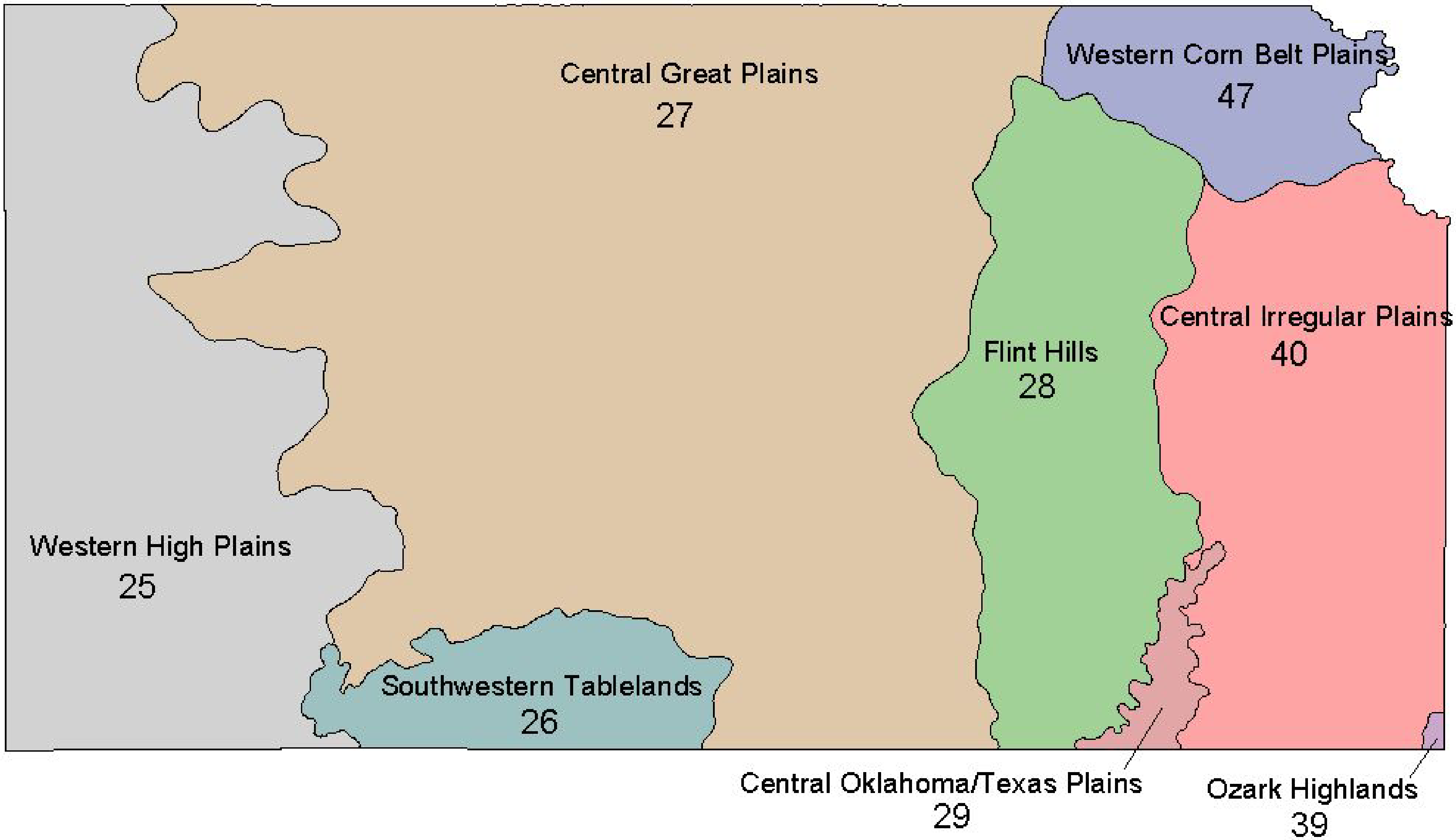
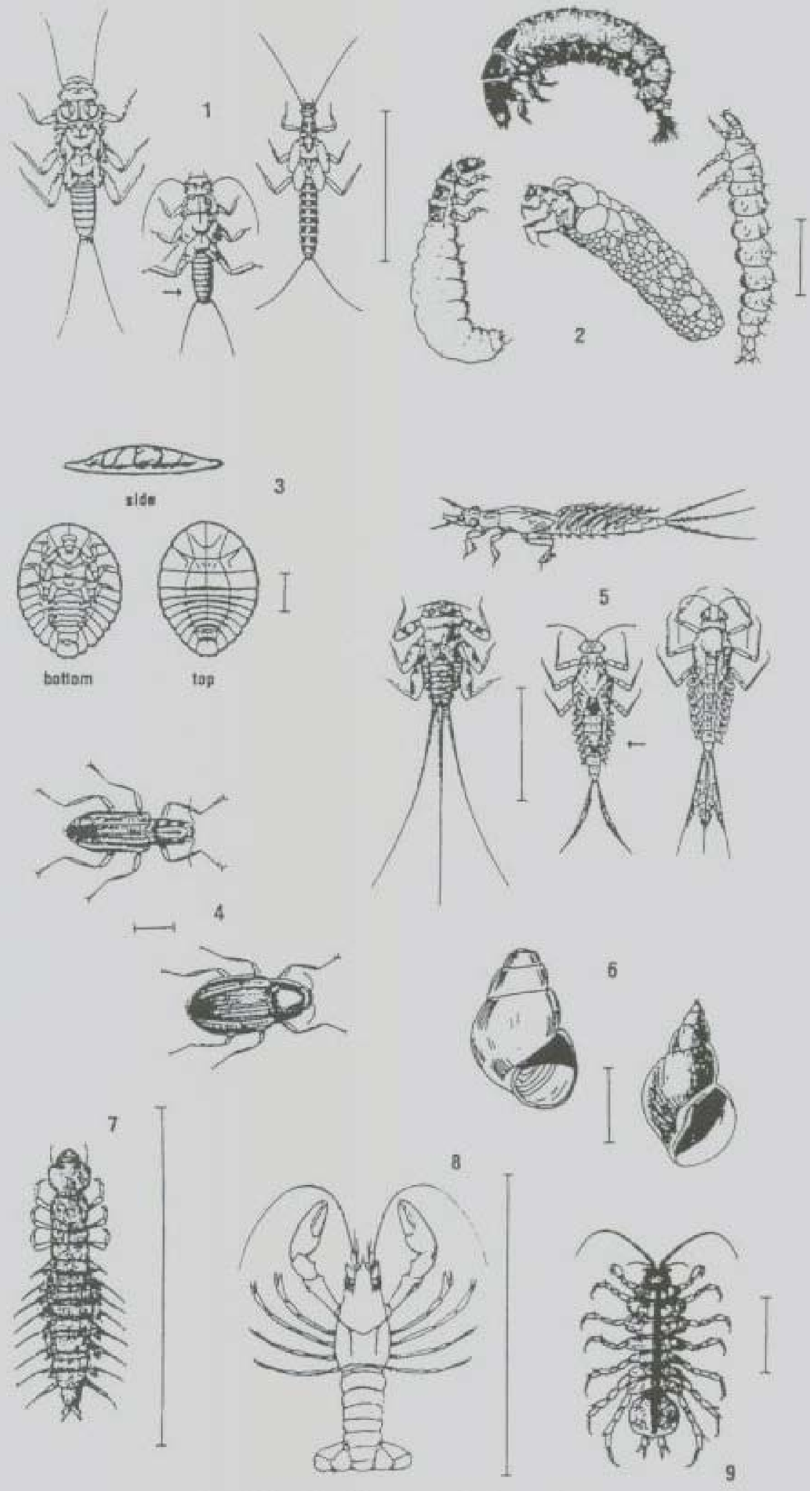
Figure 1: Recreated from Chapman et al., 2001, Ecoregions of Nebraska and Kansas (poster).



Attachment I - From USDA/NRCS Technical Note 99-1



Bar line indicate relative size

Stream Invertebrates

Group One Taxa

Pollution sensitive organisms found in good quality water.

1 **Stonefly Order Plecoptera.** 1/2" to 1 1/2", 6 legs with hooked antenna, 2 hair-line tails. Smooth (no gills) on lower half of body (see arrow).

2 **Caddisfly: Order Trichoptera.** Up to 1", 6 hooked legs on upper third of body, 2 hooks at back end. May be in a stick, rock, or leaf case with its head sticking out. May have fluffy gill tufts on underside.

3 **Water Penny: Order Coleoptera.** 1/4", flat saucer-shaped body with a raised bump on one side and 6 tiny legs and fluffy gills on the other side. Immature beetle.

4 **Riffle Beetle: Order Coleoptera.** 1/4", oval body covered with tiny hairs, 6 legs, antennae. Walks slowly underwater. Does not swim on surface.

5 **Grilled Snail: Class Gastropoda.** Shell opening covered by thin plate called operculum. When opening is facing you, shell usually opens on right.

6 **Mayfly: Order Ephemeroptera.** 1/4" to 1", brown, moving, plate-like or feathery gills on the sides of lower body (see below), 6 large hooked legs, antennae, 2 or 3 long hair-like tails. Tails may be webbed together.

7 **Dobsonfly (hellgrammite): Family Corydalidae.** 3/4" to 4", dark-colored, 6 legs, large pinching jaws, eight pairs feelers on lower half of body with paired cotton-like gill tufts along underside, short antennae, 2 tails, and 2 pairs of hooks at back end.

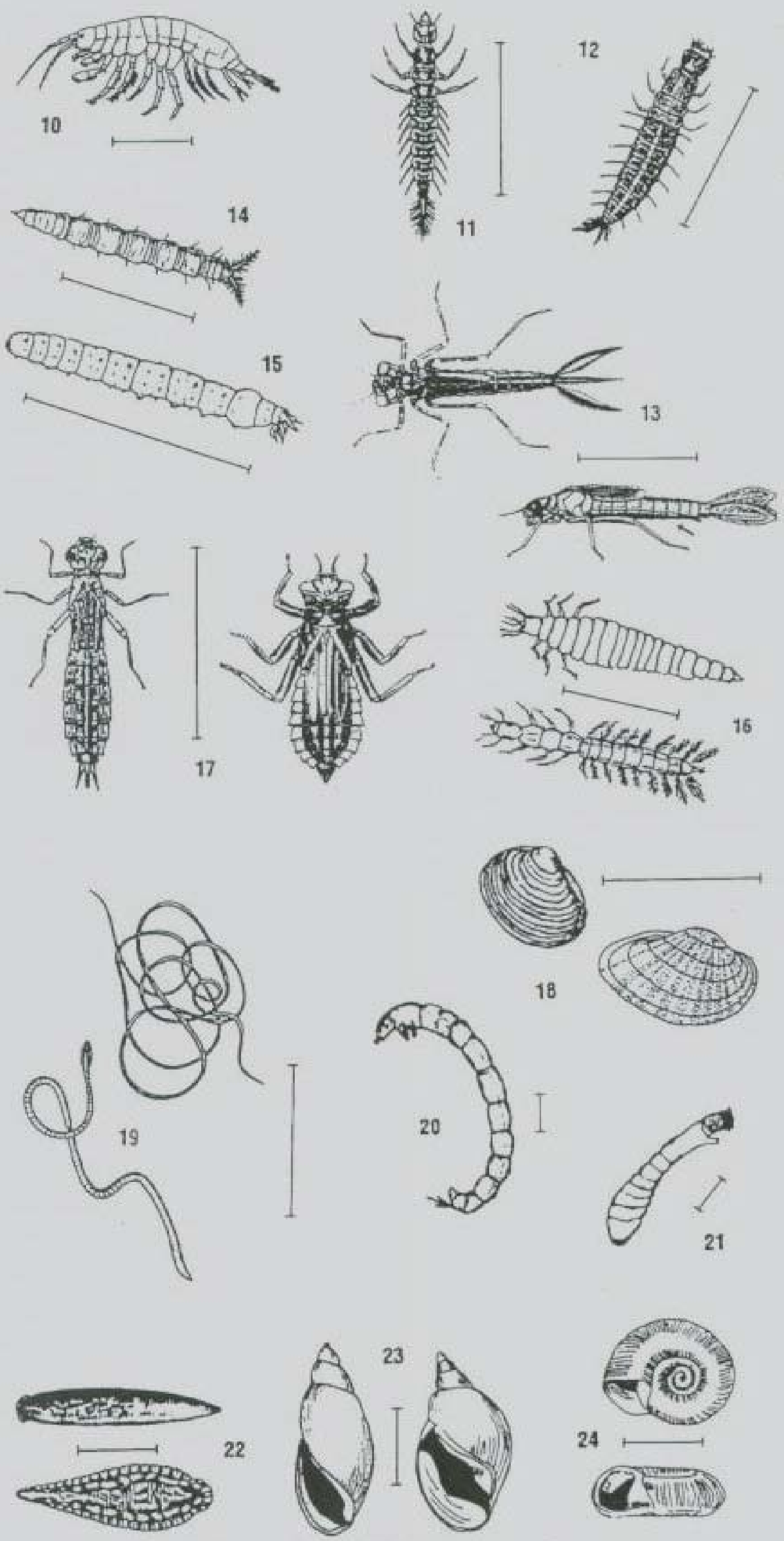
Group Two Taxa

Somewhat pollution tolerant organisms can be in good or fair quality water.

8 **Crayfish: Order Decapoda.** Up to 6", 1 large claws, 8 legs, resembles small lobster.

9 **Sowbug: Order Isopoda.** 1/4" to 3/4", gray oblong body wider than it is high, more than 6 legs, long antennae.

Source: Izaak Walton League of America, 707 Conservation Lane, Gaithersburg, MD 20878-2983. (800) BUG-IWLA



Bar line indicate relative size

Group Two Taxa

Somewhat pollution tolerant organisms can be in good or fair quality water.

10 **Scud: Order Amphipoda.** 1/4", white to gray, body higher than it is wide, swims sideways, more than 6 legs, resembles small shrimp.

11 **Alderfly Larva: Family Sialedae.** 1" long. Looks like small Hellgramite but has long, thin, branched tail at back end (no hooks). No gill tufts underneath.

12 **Fishfly Larva: Family Cordalidae.** Up to 1/2" long. Looks like small hellgramite but often a lighter reedish-tan color, or with eyllowish streaks. No gill tufts underneath.

13 **Damselfly: Suborder Zugoptera.** 1/2" to 1" large eyes, 6 thin hooked legs, 3 broad oar-shaped tails, positioned like a tripod. Smooth (no gills) on sides of lower half of body. (See arrow.)

14 **Watersnipe Fly Larva: Family Atherici-dae (Atherix).** 1/4" to 1", pale to green, tapered body, many caterpillar-like legs, conical head, feathery "horns" at back end.

15 **Crane Fly: Suborder Nematocera.** 1/3" to 2", milky, green, or light brown, plump caterpillar-like segmented body, 4 finger-like lobes at back end.

16 **Beetle Larva: Order Coleoptera.** 1/4" to 1", light-colored, 6 legs on upper half of body, feelers, antennae.

17 **Dragon fly: Suborder Anisoptera.** 1/2" to 2", large eyes, 6 hooked legs. Wide oval to round abdomen.

18 **Clam: Class Bivalvia.**

Group Three Taxa

Pollution tolerant organisms can be in any quality of water.

19 **Aquatic Worm: Class Oligochaeta.** 1/4" to 2", can be very tiny, thin worm-like body.

20 **Midge Fly Larva: Suborder Nemato-cera.** Up to 1/4", dark head, worm-like segmented body, 2 tiny legs on each side.

21 **Blackfly Larva: Family Simulidae.** Up to 1/4", one end of body wider. Black head, suction pad on other end.

22 **Leech: Order Hirudinea.** 1/4" to 2", brown, slimy body, ends with suction pads.

23 **Pouch Snail and Pond Snails: Class Gastropoda.** No operculum. Breath air. When opening is facing you, shell usually open to left.

24 **Other Snails: Class Gastropoda.** No operculum.Breath air. Snail shell coils in one plane.