Technical Support Documentation for the Narrative Biocriteria Standard

April 2007

Arizona Department of Environmental Quality

Executive Summary

This Biocriteria Technical Support document provides the technical rationale for development of Arizona's macroinvertebrate Indexes of Biological Integrity. These Indexes provide a quantitative tool by which to interpret the new narrative biocriteria standard. Information about the narrative standard, sampling methods, and the method for determining a standards violation are provided in the "*Narrative Biocriteria Standard Implementation Procedures*" document (ADEQ, 2005). Topics covered in this document include the following:

- General approach for developing multi-metric Indexes of Biological Integrity,
- Reference condition and site selection criteria,
- Development of the multimetric Indexes of Biological Integrity,
- Updates to the IBI scoring criteria
- Current metric and IBI thresholds

The warm and cold water Index of Biological Integrity scores are updated in this document. These Index scores incorporate various corrections and an update with more recent reference site data collected since the late 1990's. These revised values constitute the current macroinvertebrate Index scores for use in interpreting the new narrative biocriteria standard. The rationale for selection of the 25th percentile of reference condition is also discussed.

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A. Introduction

ADEQ has proposed a new biocriteria narrative standard to be included in the revised Surface Water Quality Standards (R-18-11-108.01) in 2006. A description of this narrative standard, its applicability, methods for sample collection, and method for determining a standards violation are described in the document entitled *"Narrative Biocriteria Standard Implementation Procedures for Wadeable, Perennial Streams"(ADEQ, 2006).* While that document provides guidance for implementing the new biocriteria standard, the technical background for development of the standard is not included. This document provides that technical background material. Topics covered in this document include the following subject areas:

- General approach for developing multi-metric Indexes of Biological Integrity (IBI),
- Reference condition and site selection criteria,
- Development of the multimetric Indexes of Biological Integrity,
- Updates to the scoring criteria.
- Current metric and Index of Biological Integrity thresholds

B. General approach for developing multi-metric Indexes of Biological Integrity

The general approach to developing biocriteria involves these key components: 1) Defining the biological assemblage and bioassessment protocols, 2) Determining reference conditions, 3) Classifying streams across the state into regions with similar biological composition, 4) Developing a bioassessment tool. Developing the multimetric indexes of biological integrity involved testing and selection of metrics for a warm and cold water index, identification of reference scoring thresholds for each metric, then combining the metrics into an index and selecting statistical criteria for the IBI thresholds.

ADEQ began to develop a Biocriteria Program in 1992 with a statewide reference site monitoring network and creation of a standard operating procedures manual for macroinvertebrates (Meyerhoff and Spindler, 1994). Updated methods (Lawson, 2005) and a quality assurance plan (ADEQ, 2005) have since been published. A classification analysis of the statewide biological data was conducted to determine regions of similar macroinvertebrate communities. An elevation-based classification system was the result, consisting of two broad macroinvertebrate regions and community types: 1) a warm water community located at <5000' and a cold water community located at >5000' (Spindler, 2001). All small to medium-sized, wadeable, non-effluent dependent, perennial streams located in these regions, with a few exceptions, are predicted to have the same general macroinvertebrate community type. Indexes of Biological Integrity were then developed for warm water and cold water communities, utilizing the statewide network of reference data (Gerritsen and Leppo, 1998; Leppo and Gerritsen, 2000).

C. Reference condition

The bioassessment approach involves characterizing reference conditions upon which comparisons can be made, then identifying appropriate biological attributes with which to measure the condition. A stream reach is in reference condition when ecological conditions and the associated biological diversity are greatest for a region. Reference site data provide a baseline from which to develop an index for assessment of biological integrity.

In Arizona, regional reference conditions have been developed statewide for bioassessment purposes; with 30-50 reference sites each for warm and cold water stream types (Figure 1). The warm and cold water stream reference sites are listed in Appendices A and B. Physical, chemical and biological data were collected for 5 years at these sites to quantify natural variability in macroinvertebrate communities and for index development purposes. Initially physical conditions were used to screen for reference sites, which were then confirmed using biological information. All the following conditions must be met for a stream reach to be considered reference. These are <u>minimum</u> criteria which must be met.

- No known discharges upstream
- No major impoundments upstream
- No channel alterations at the site
- Located >0.5 km downstream of road crossings
- Site should be free of local land use impacts
- Site should be truly perennial (presence of fish, univoltine insects, riparian indicators)
- No violations of pH or dissolved oxygen water quality standards
- ADEQ Habitat score > 14
- Accessible (within a 2-hour hike or 3-4 mi from nearest road)

While it is true that all reference sites must meet those minimum criteria, not all sites that meet those criteria are truly reference. There are a great many sites that meet these minimum criteria, but most of those are non-reference sites and are not suitable for setting the regional expectation of best biological condition.

Most sites sampled were initially recommended by land or resource managers as best available sites in each basin or were selected from Wild and Scenic River documents or were listed as unique waters. This initial selection process ensured that biological samples would be collected from "best available" stream conditions in each watershed across the state. Methods for collecting habitat measurements and calculating the ADEQ Habitat score are found in the ADEQ Manual of Procedures for the Sampling of Surface Waters (Lawson, 2005).

Reference site data alone is insufficient to test and calibrate a multimetric index. There must be some samples from stressed sites by which to discriminate reference from stressed and to help calibrate the index. Stressed sites included stream reaches which have one or more of the following criteria:

- Known discharges occur upstream
- Channel alterations occur upstream

- Substantial bank erosion occurs within the study reach
- Land use impacts are occurring adjacent to the stream
- Water quality standards are exceeded
- ADEQ Habitat score <14

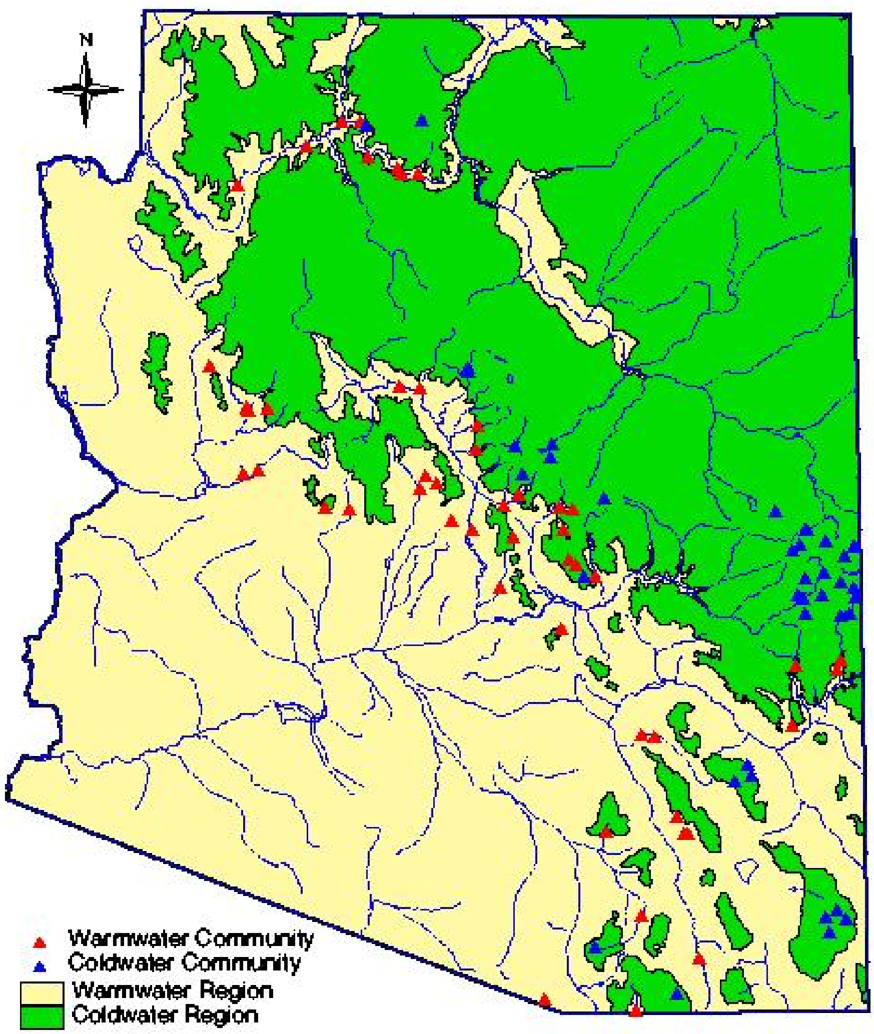

Figure 1. Warm and cold water macroinvertebrate reference sites across Arizona in two regions: cold water >5000' and warm water <5000' elevation.

D. Development of the multi-metric Indexes of Biological Integrity

Multimetric Indexes of Biological Integrity (IBI) have been developed for many ecoregions of the country and are generally accepted as the tool for use in biological assessments of aquatic communities. The USEPA publication, *Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers* (Barbour et al, 1999) provides guidance on monitoring of biological communities and development of analytical tools, including multimetric indexes, for assessment purposes. With assistance from TetraTech Inc., ADEQ followed the USEPA guidance in development of multi-metric Indexes of Biological Integrity for warm and coldwater macroinvertebrate communities of Arizona.

Tetra Tech tested and selected metrics for inclusion in the warm and cold water Indexes (Gerritsen and Leppo, 1998; Leppo and Gerritsen, 2000). This analysis consisted of testing 30 metrics using a box and whisker plot technique to determine which metrics best distinguished between reference and impaired conditions. In addition, metrics were selected for responsiveness to disturbance in four metric categories: richness, composition, tolerance and functional feeding groups. General performance criteria for metric selection were as follows:

- Best discriminatory efficiency between reference and impaired sites,
- At least one metric chosen from each of the four metric categories,
- A target of 6-12 metrics was considered best for a robust index
- Minimization of redundancy among metrics through correlation analysis, and
- Metrics responded to different types of stressors (nutrients, habitat)

A more specific rationale for selection of each metric and the discriminatory power of each selected metric is provided in the following tables. The rationale for the warm water metrics is provided in Table 1 and the rationale for selection of cold water metrics is presented in Table 2. The discriminatory ability of the metrics was tested via two methods: the boxplot scoring method (Barbour et al., 1996) and the percentile of stressed sites correctly classified (Leppo and Gerritsen, 2000). The latter method was applied to the cold water dataset because there was a sufficient number of samples to conduct this test.

The boxplot scoring method examines the degree of overlap of metric value ranges between reference and stressed groups of sites in a box and whisker plot. Scores of 0, 1, 2, or 3 points are assigned to metrics, based on what extent the interquartile ranges and medians of the reference and stressed site distributions overlap (Figure 2). Metrics with a high score of 3 represent high discriminatory ability with no overlap of the interquartile range. Metrics with a score of 2 represent good discriminatory ability with some overlap of the interquartile ranges, but with both medians outside the interquartile ranges. Metrics with a score of 1 represent low discriminatory power with moderate overlap of interquartile ranges but median of stressed sites is below the interquartile range of reference sites. Metrics with a score of 0 represent poor discriminatory power with extensive overlap of the interquartile ranges or overlap of both medians in the interquartile ranges.

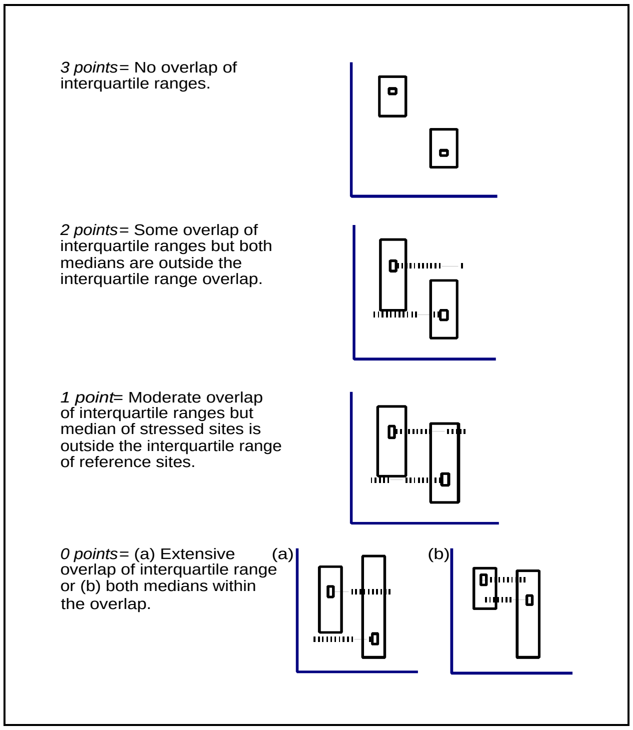

Figure 2. Discriminatory power evaluation of metrics using boxplot method (Barbour et al., 1996)

Table 1. Metric selection rationale for the AZ warm water Index of Biological Integrity.

Metric category	Metric	Discriminatory power (ref-edw) using boxplot scoring method	Rationale for metric selection
Richness	Total taxa	3	Good overall response to stress
	Mayfly taxa	3	Best response to stress (eg. toxics)
	Caddisfly taxa	3	Responds more strongly to habitat stress
	Diptera taxa	2	Moderate response to stress
Composition	% 1 Dominant	1	Second composition indicator, nutrient response
	% Mayflies	3	Good response to stress
Tolerance	Hilsenhoff Biotic Index	3	Needed for balance among metric categories
Trophic	Scraper taxa	3	Best response to nutrient enrichment / EDW conditions
	% Scrapers	3	Better response to increased cover of filamentous algae, not correlated with Scraper taxa metric (r = 0.4)

Table 2. Metric selection rationale for the AZ Cold water Index of Biological Integrity.

Metric category	Metric	Discriminatory power (ref-stressed) using boxplot scoring method	Discriminatory power (ref-stressed) using Percentage of stressed sites correctly classified at the 25th percentile	Rationale for metric selection
Richness	Total taxa	3	75%	Good response to overall stress
	Diptera taxa	3	63%	Good response to stress (eg. nutrients & sediment)
	Intolerant taxa	3	100%	Best response to stress
Composition	% Stoneflies	2	63%	Best composition metric
Tolerance	HILSENHOFF BIOTIC INDEX	3	69%	Good tolerance metric
Trophic	Scraper taxa	3	69%	Good response to stress (eg. Nutrients & sediment)
	% Scrapers	3	81%	Best response to stress among all trophic measures

The discriminatory ability of the cold water metrics was also tested using the percentile of stressed sites correctly classified at the 25th percentile. This method is very similar to the boxplot method, since the 25th percentile of reference is the lower interquartile boundary of a box and whisker plot, which is the defining characteristic of the boxplot method. A high percentage of sites correctly classified indicates good discriminatory power (>75%). Intermediate discriminatory power is represented by 50-75% of sites correctly classified. Weak discriminatory power is represented by <50% of sites correctly classified.

Six to ten metrics were selected from each of the four metric categories to form the Indexes. These were metrics with the best discriminatory power or ability to detect stressed samples from reference samples. Only metrics which were not significantly correlated with other metrics were included in the final index (Gerritsen and Leppo, 1998; Leppo and Gerritsen, 2000). While the two trophic level metrics, scraper taxa richness and percent scrapers, appear to be similar metrics, they respond differently to nutrient enrichment (algae cover) and are uncorrelated metrics. Therefore both metrics were selected for the final warm water index. Discriminatory ability of the seven cold water and nine warm water metrics and the rationale for selecting these metrics are presented in Tables 1 and 2.

Threshold values for each metric were derived from the composite statewide all-sample (reference to stressed sites) dataset. The 95th percentile of all samples was selected for metrics that decrease with disturbance and the 5th percentile of all samples was selected for metrics that increase with disturbance (Table 3). The 95th and 5th percentile values were selected to represent best conditions of biological integrity, while excluding maximum or outlier values in the dataset.

Table 3. Scoring thresholds for warm and cold water metrics, used in the original Arizona Indexes of Biological Integrity (Gerritsen & Leppo, 1998; Leppo & Gerritsen, 2000).

Index of Biological Integrity	Metric	Metric threshold value
Warm water	Total taxa	34
Warm water	Trichoptera taxa	8.0
Warm water	Ephemeroptera taxa	7.0
Warm water	Diptera taxa	9.0
Warm water	Scraper taxa	7.0
Warm water	Percent scraper	25.1
Warm water	Percent Ephemeroptera	70.8
Warm water	Percent Dominant Taxon	20.9
Warm water	Hilsenhoff Biotic Index	4.9
Cold water	Total taxa	23
Cold water	Diptera taxa	5.0
Cold water	Intolerant taxa	4.0
Cold water	Scraper taxa	5.0
Cold water	Percent scraper	8.8
Cold water	Percent Plecoptera	1.3
Cold water	Hilsenhoff Biotic Index	5.5

Once the metrics were selected for each Index, all the reference Index scores were evaluated together using box and whisker plots to develop scoring criteria for the Index as a whole. The box and whisker plots of reference and stressed samples were evaluated to identify which percentile statistic best differentiated between the two distributions.

The box and whisker plots for warm water stream communities (Figure 3) displayed a significant difference between the two groups of samples at the 25th percentile of reference. Typically in index development work, a statistic which represents a statistical difference between reference and stressed samples, and which is based on the reference distribution of scores is identified for use as a minimum threshold or biocriterion. In Figure 3 the reference median value (IBI=62) was greater than the 75th percentile of the impaired sample values (IBI=55) and the median of the impaired sample values (IBI=47) was less than the 25th percentile of reference values (IBI=53). Using the boxplot scoring method that was applied to the metrics, the overall Warm Water Index 25th percentile threshold has a score of 2 points, indicating good discriminatory ability. Therefore the 25th percentile of the reference distribution was selected to be used as the minimum scoring threshold needed to attain the aquatic life use because a significant difference occurred between the reference and stressed biological communities at that threshold level. Thresholds for different levels of attainment listed in Table 4 were initially used for bioassessment purposes and were based on the 25th, 75th and 12.5th percentiles of the reference distribution.

There has been some criticism for use of the 25th percentile as the biocriteria threshold, based on the assumption that this threshold will identify unimpacted reference reaches as impaired 25 percent of the time. It is true that we are accepting a 25% error rate; however there are reasons why this rate is acceptable. First, many sites which were initially designated as "reference" were actually only the "best available" stream sites in a region. While "reference" reaches of the desert stream Aravaipa Creek, for example, are in a Wilderness Area, much of the watershed upstream is intensively farmed. These "best available" sites tend to have lower IBI scores, so we acknowledge that there is some uncertainty in reference quality in the low end of "reference" scores. There are also samples in the dataset from streams which were thought to be perennial, which later were determined to be intermittent. Second, ADEQ is proposing very conservative thresholds to define a standards violation, with the 10th percentile as the absolute threshold for a violation, the 25th percentile as the minimum threshold for protecting the aquatic life use, and 10-25th percentile as inconclusive wherein a verification sample is required. The chance of making a Type 1 false positive error is very low. Third, a robust dataset of approximately 200 samples collected statewide was used to develop each of the Indexes and the boxplot test is significant because a large number of reference and stressed samples was used to identify the 25th percentile of reference IBI scores as the threshold for impairment.

Table 4. Initial Arizona Warm water Index of Biological Integrity thresholds, based on 1992-95 reference distribution.

Waterbody type	Exceptional (>75th Percentile of reference)	Good (>50th percentile, <75th percentile of reference)	Fair (>12.5th percentile, <50th percentile of reference)	Poor (<12.5th percentile of reference)
Warm water	73 - 100	53 - 72	27 - 52	0 - 26
Cold water	97 - 100	88 - 96	44 - 87	0 - 43

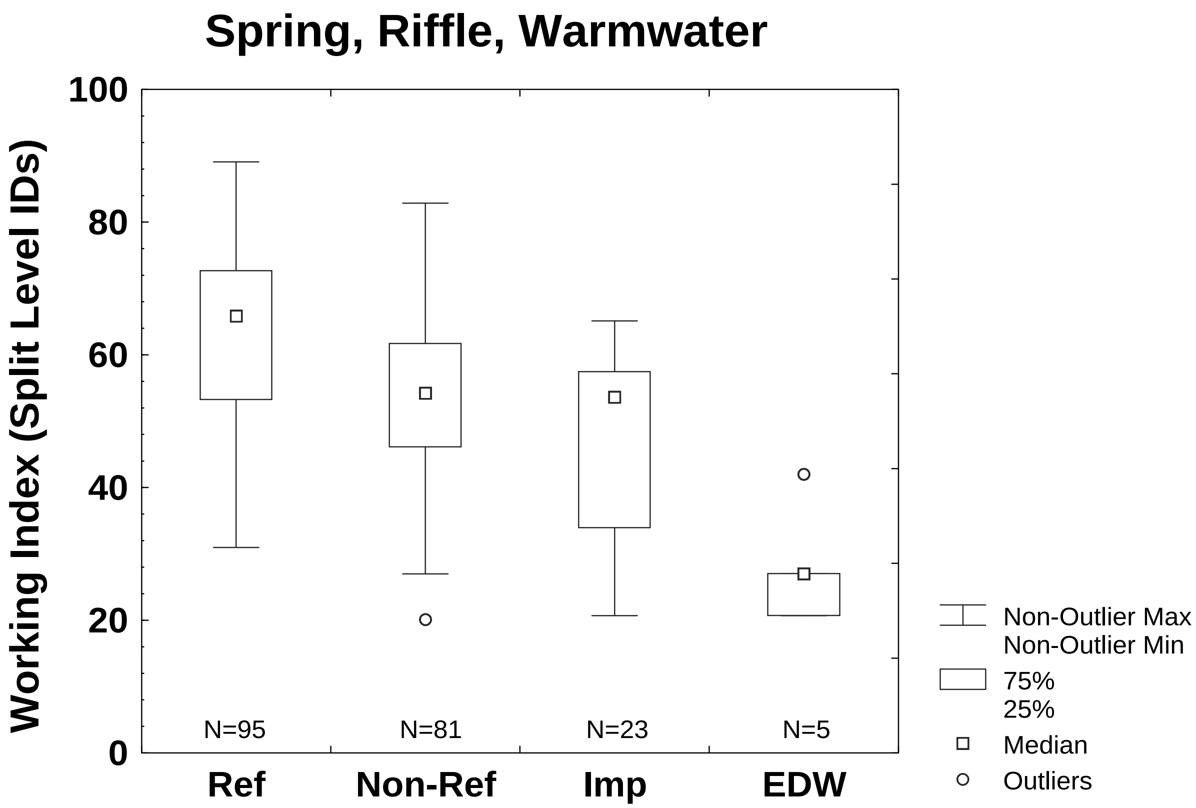

Figure 3. Warm water macroinvertebrate IBI boxplot distributions for samples collected during 1992-1995. Site Class categories are 1=reference, 2=non-reference, 3=stressed. Taxonomy is split-level identification with genus level taxonomy for insects and midges aggregated to the family level.

The box and whisker plot for cold water stream communities (Figure 4) also displays a significant difference between the two groups of samples at the 25th percentile of reference. There is a distinct separation between the reference population and the non-reference and stressed distributions at the 25th percentile of the reference. In Figure 4 the 25th percentile of the reference IBI distribution did not overlap the interquartile range of either the non-reference or stressed sample distributions. Using the boxplot scoring method, the overall Cold water Index 25th percentile threshold has a score of 3 points, indicating excellent discriminatory ability. Therefore the 25th percentile of the reference distribution was selected to be used as the minimum scoring threshold needed to attain the aquatic life use. Thresholds for different levels of attainment listed in Table 4 were initially used for bioassessment purposes and were based on the 25th, 75th and 12.5th percentiles of the reference distribution.

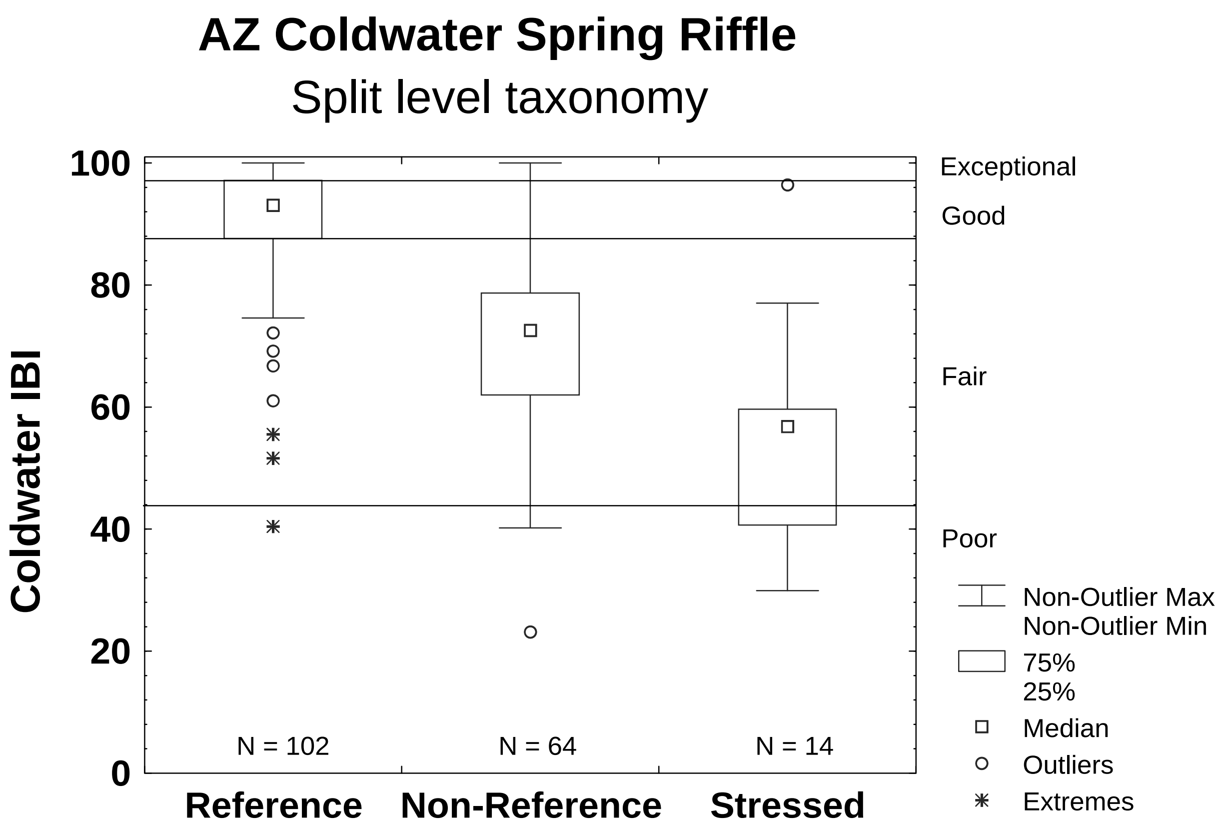

Figure 4. Arizona cold water IBI boxplot distributions for samples collected during 1992-1998. Split-level taxonomy refers to genus level taxonomy for insects, with midges lumped at the family level. Assessment categories of Exceptional, Good, Fair and Poor are signified by threshold lines at the 75, 25 and 12.5 percentile.

E. Updates to the IBI scoring criteria

Warm water metrics and IBI

The warm water metric and Index of Biological Integrity thresholds were updated to include data through 2003. Metric thresholds were recalculated based on 1992-2003 data for the whole dataset (reference + non-reference + stressed). Only the metrics that were tested and selected for inclusion in the warm water Index (Gerritsen and Leppo, 1998) were updated in this analysis. The metric thresholds consist of 95th percentile values of all samples for sensitive metrics and 5th percentile of all samples for tolerant metrics. The updated warm water metric threshold values are shown in Table 5. The taxa richness metrics increased in value due to: 1) addition of 33 new reference samples collected 1996-2003, 2) inclusion of Verde River samples, which were omitted in the original Warm Water IBI report (Gerritsen & Leppo, 1998) because these samples were part of the calibration dataset and 3) corrections in database calculations of the Hilsenhoff Biotic Index (HBI) and total taxa metrics which resulted in greater taxa richness but similar HBI values. The warm water IBI scores were recalculated based on 1992-2003 reference site data (n=128). As a result of greater metric thresholds, the IBI scores decreased somewhat. A boxplot analysis was conducted to evaluate whether the 25th percentile was still an adequate threshold for discriminating impairment (Figure 5). The revised warm water Index discriminates well between reference and stressed site classes at the 25th percentile of reference scores. This threshold will be maintained as the goal needed to protect aquatic life in warm water streams located at <5000' elevation.

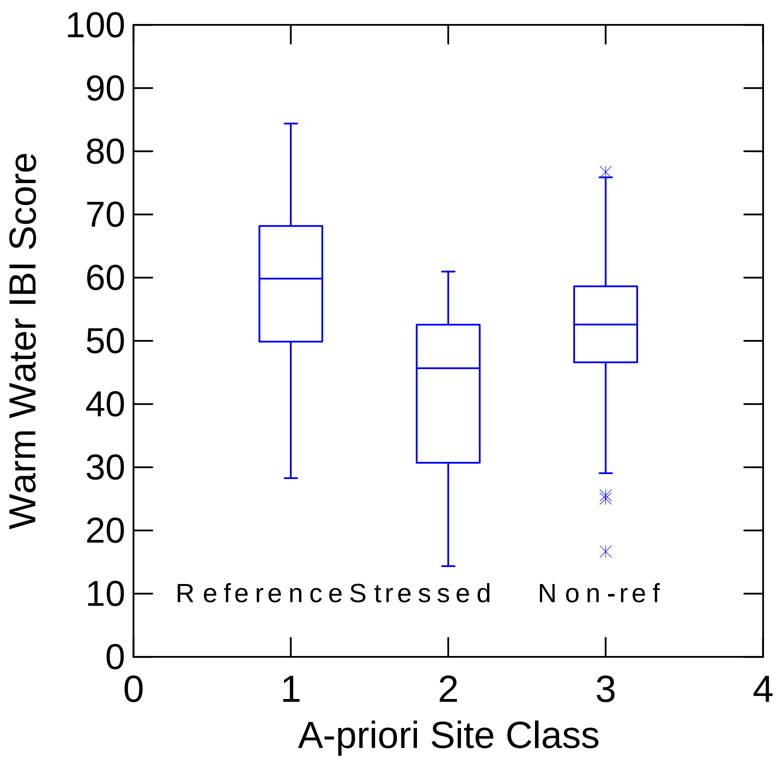

Figure 5. Updated Warm water macroinvertebrate Index of Biological Integrity boxplot comparison of reference and stressed samples, 1992-2003 dataset. Site Class categories are 1=reference, 2=stressed, 3=non-reference. Taxonomy is split-level identification with genus level taxonomy for insects and midges aggregated to the family level.

Cold water metrics and IBI

The cold water metrics and Index of Biological Integrity thresholds were also updated to correct errors in the original metric thresholds and to include data through 2003. In the original Cold water IBI analysis (Leppo & Gerritsen, 2000) the 25th percentile metric threshold was used instead of the 95th percentile value. This error caused the metric thresholds to be unusually low and the cold water IBI values and threshold to be unusually high. This error has been corrected by using the 95th percentile of all samples value in this analysis. An additional 75 sample values (including 5 reference samples) collected from 1999-2003 were included in this analysis to bring the metric and IBI thresholds up to date.

The ***cold water metric thresholds*** were recalculated based on 1992-2003 data for the whole dataset (reference + non-reference + stressed). Only the metrics that were tested and selected for inclusion in the original cold water Index (Leppo & Gerritsen, 2000) were updated in this analysis. The metric thresholds consisted of 95th percentile values of all samples for sensitive metrics and 5th percentile of all samples for the HBI metric. The updated cold water metric threshold values are shown in Table 5. There is a large increase in all metrics, except the HBI metric which decreased in value. The changes in metric values were due to: 1) addition of 75 new reference samples collected 1999-2003, 2) corrections in database calculations of the HBI and Total Taxa metrics, and 3) change from use of 25th to 95th percentile of metric sample values.

Cold Water IBI scores were re-evaluated based on 1992-2003 reference site data (n=114). A boxplot analysis was conducted to evaluate whether the 25th percentile was still an adequate threshold for discriminating impairment (Figure 6). The 25th percentile score in this analysis has decreased from a threshold of 88 to define attainment in the Gerritsen and Leppo analysis to a threshold of 52 in this analysis. However, this revised cold water Index discriminates well between reference and stressed site classes at the 25th percentile of reference scores. This threshold will be maintained as the goal needed to protect aquatic life in warm water streams located at <5000' elevation. The updated cold water IBI thresholds are shown in Table 6.

Overall accuracy of the Indexes

The discriminatory ability of the warm and cold water Indexes was evaluated to determine overall accuracy. This analysis involved calculating a percentage of samples achieving the appropriate attainment class. The accuracy of the **warm** water Index was good with 77% (n=98/128) of a-priori identified reference sites attaining the 25th percentile of reference IBI score. The false positive error rate for warm water reference samples was low, with 10% (n=13/128) of a-priori identified reference sites violating the 10th percentile of reference IBI score. The false negative error rate was much higher than the false positive, with 48% (n=11/23) of a-priori identified stressed warm water samples attaining the 25th percentile of reference IBI score. Some of those samples were placed in the a-priori "stressed" category because of lack of habitat (bedrock dominated) or low flow/intermittency but have proved to be functioning communities. If those samples were removed, the false negative rate would be decreased.

The accuracy of the **cold** water Index was good with 78% (n=89/114) of a-priori identified reference sites attaining the 25th percentile of reference IBI score. The false positive error rate for cold water reference samples was low, with 11% (n=12/114) of a-priori identified reference sites violating the 10th percentile of reference IBI score. The false negative error rate was very low, with only 6% (n=1/16) of a-priori identified stressed warm water samples attaining the 25th percentile of reference IBI score. The overall discriminatory ability of both the cold and warm water Indexes of Biological Integrity is satisfactory, with a high rate of accuracy in correctly identifying reference and fairly low rates of false positive and false negative error rates.

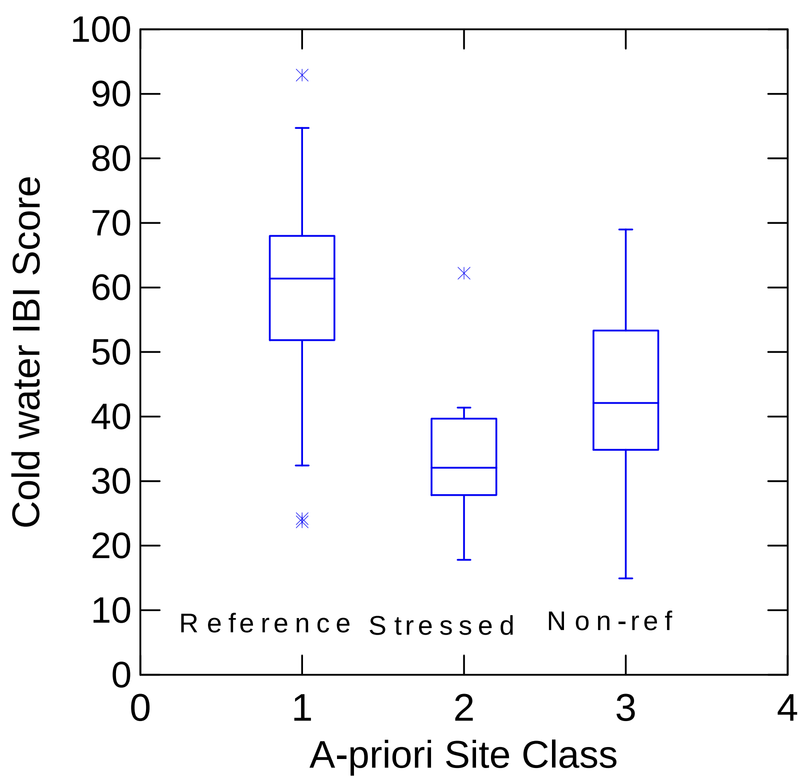

Figure 6. Updated Cold water macroinvertebrate Index of Biological Integrity boxplot comparison of reference and stressed samples, 1992-2003 dataset. Site Class categories are 1=reference, 2=stressed, 3=non-reference. Taxonomy is split-level identification with genus level taxonomy for insects and midges aggregated to the family level.

Table 5. Updated scoring thresholds for warm and cold water metrics, used in the 2006 Arizona Indexes of Biological Integrity.

Index of Biological Integrity	Metric	Metric threshold value
Warm water	Total taxa	37
Warm water	Trichoptera taxa	9.0
Warm water	Ephemeroptera taxa	9.0
Warm water	Diptera taxa	10.0
Warm water	Scraper taxa	7.0
Warm water	Percent scraper	23.7
Warm water	Percent Ephemeroptera	70.0
Warm water	Percent Dominant Taxon	19.1
Warm water	Hilsenhoff Biotic Index	4.89
Cold water	Total taxa	38
Cold water	Diptera taxa	11
Cold water	Intolerant taxa	6
Cold water	Scraper taxa	11
Cold water	Percent scraper	45.1
Cold water	Percent Plecoptera	19.1
Cold water	Hilsenhoff Biotic Index	4.23

F. Current metric and IBI thresholds

The warm and cold water Index of Biological Integrity Scores provided in Table 6 represent the updated macroinvertebrate Index scores for use in interpreting the new narrative biocriteria standard. These Index scores incorporate various corrections and an update with more recent reference site data collected since the late 1990's. These Index scores are derived from the box and whisker plots shown in Figures 5 and 6. The bioassessment result categories that are listed in Table 6 are defined by the 10^{th} and 25^{th} percentiles of reference condition. A single sample violation of the biocriterion occurs when IBI scores are equal or less than the 10^{th} percentile value. A single sample IBI score that is at or above the 25^{th} percentile value meets the biocriterion. Single sample IBI scores that fall between the 10^{th} and 25^{th} percentile values are termed inconclusive and a verification sample is required. If the verification sample falls below the 25^{th} percentile IBI score, then a violation of the biocriterion occurs. More interpretation of the biocriterion is provided in the Narrative Biocriteria Standard Implementation Procedures document (ADEQ, 2006).

Table 6. Updated 2006 Arizona macroinvertebrate Indexes of Biological Integrity Scores.

Macroinvertebrate bioassessment result	Index of Biological Integrity Score	
	Cold water	Warm water
Greater than the 25^{th} percentile of reference condition	≥ 52	≥ 50
Between the 10th and 25^{th} percentile of reference condition	46 – 51	40 – 49
Less than the 10^{th} percentile of reference condition	≤ 45	≤ 39

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Appendix A: Warm water Site List used to develop the Arizona Warm Water Index of Biological Integrity (1992-1996)

Site Class	ADEQ WQDB Number	Station ID-Vector method	Waterbody Name	Location	LAT_DMS	LONG_DMS	Elevation	Catchment Area mi2
R	100713	MGANT011.29	ANTELOPE CREEK	ABV ROAD CROSSING NR STANTON	341145.5	1124251.5	3850	5.2
R	100716	SPARA007.92	ARAVAIPA CANYON CREEK	AT HELLS HALF ACRE CANYON (WEST END)	325439.4	1103259.1	2650	493.5
R	100211	SPARA010.40	ARAVAIPA CANYON CREEK	AT PARSONS CANYON (EAST END)	325412.5	1102739.5	2980	400.2
R	100215	SPBAS000.75	BASS CANYON	ABOVE DOUBLE R CANYON CONFLUENCE	322106.5	1101405.5	4040	33.6
R	100420	UGBLR008.07	BLUE RIVER	ABOVE FRITZ RANCH (LOWER)	331936.1	1091122.6	4310	489.7
R	100421	UGBON004.82	BONITA CREEK	ABOVE CONFLUENCE WITH GILA RIVER	325723.4	1093152.2	3180	302.0
R	100426	BWBRO019.21	BURRO CREEK	ABOVE CONF WITH FRANCIS CREEK	344438.0	1131422.8	3100	169.2
R	100431	SRCGN007.70	CAMPAIGN CREEK	AT SUPERSTITION WILDERNESS BOUNDARY	333126.8	1110511.7	3355	9.6
R	100480	SCCIE012.55	CIENEGA CREEK	ABOVE THE NARROWS	315305.2	1103315.2	4050	199.3
R	100432	BWCNG003.82	CONGER CREEK	BELOW CONGER SPRING	344531.1	1130710.4	4360	15.2
R	100531	SRD4E003.91	DEER CREEK	AT MAZATZAL WILDERNESS BOUNDARY	340235.5	1112513.5	3630	8.1
R	100536	UGEAG023.34	EAGLE CREEK	BELOW GAGING STATION	331739.5	1092938.5	4645	380.4
R	100555	BWFRA000.79	FRANCIS CREEK	ABOVE ROAD CROSSING	344501.0	1131516.9	3200	
R	100556	BWFRA001.73	FRANCIS CREEK	ABV SPENCER CREEK CONF NEAR PUMP STATION	344547.5	1131548.5	3280	127.5
R	100563	SRHAG003.51	HAIGLER CREEK	1.4 MILES BELOW ALDERWOOD RECREATION SITE	341213.5	1110028.5	4870	35.5

R	100407	BWPEE002.38	PEOPLES CANYON CREEK	BELOW SOUTH PEOPLES SPRING	342234.0	1131613.0	2440	5.8
R	100619	UGPIG001.33	PIGEON CREEK	ABOVE BEAR CREEK CONFLUENCE	331634.5	1091338.5	4300	55.3
R	100620	VRPIE000.20	PINE CREEK	ABOVE EAST VERDE RIVER CONNFLUENCE	341327.5	1112916.2	3360	46.0
R	100628	SPRDC006.89	REDFIELD CANYON	BELOW SYCAMORE CANYON CONFLUENCE	322709.2	1101854.7	3900	36.7
R	100631	VRROU001.79	ROUNDTREE CREEK	THREE MILES ABV TANGLE CRK CONFLUENCE	340821.4	1115046.5	3300	11.0
R	100653	SPSPR095.71	SAN PEDRO RIVER	BELOW GRAVEYARD GULCH CONFLUENCE	313814.4	1101029.8	3920	1234.0
R	100647	BWSMR015.10	SANTA MARIA RIVER	ABV HWY 93 AND SANTA MARIA RANCH	342400.7	1131023.8	1830	770.5
R	100651	SRSPI006.86	SPRING CREEK	ABOVE BRYANT CANYON CONFLUENCE	340450.5	1110432.5	4260	87.6
R	100660	RMSYC002.33	SYCAMORE CANYON	"ENTERS SONORA, MEXICO, ABV PENASCO CANYON"	312438.7	1111144.5	3790	11.2
R	100704	MGSYD004.90	SYCAMORE CREEK	"NR DUGAS, ABV SYCAMORE RANGER STN"	342050.5	1115702.5	4090	35.8
R	100656	VRSYH000.16	SYCAMORE CREEK	TRIBUTARY TO HORSESHOE RESERVOIR	340446.5	1114204.0	2080	32.4
R	100657	VRSYM009.33	SYCAMORE CREEK	"IN MAZATZAL MTNS, ABV MESQUITE WASH CONF"	334416.5	1113054.5	2060	106.1
R	100199	VRSYW001.40	SYCAMORE CREEK	"IN WILDERNESS AREA, NR SUMMERS SPRINGS"	345256.1	1120359.0	3625	471.4
R	100669	SRTON032.31	TONTO CREEK	BLW HAIGLER CR. CONFLUENCE @ HELLSGATE	341254.5	1110556.5	3940	
R	100670	BWTRT006.15	TROUT CREEK	ABOVE DIVIDE CANYON CONFLUENCE	345913.6	1133115.5	3230	513.8
R	100672	VRVER095.54	VERDE RIVER	ABOVE PERKINSVILLE CROSSING	345337.2	1121241.4	3820	2930.2
R	100764	VRVER095.73	VERDE RIVER	NEAR PAULDEN @ INSCRIPTION POINT	345202.9	1122404.0	4200	2487.5
R	100204	VRWCL006.09	WEST CLEAR CREEK	ABOVE BULL PEN RANCH	343218.2	1114104.8	3660	219.3

R	100765	VRWBV006.79	WET BEAVER CREEK	ABOVE USGS GAGE	344023.7	1114006.0	4025	110.8
NR		MGAGF064.91	AGUA FRIA RIVER	Above confluence with Big Bug Creek			3480	402.7
NR	100422	CMBRA000.29	BRIGHT ANGEL CREEK	BELOW PHANTOM RANCH	360608.5	1120542.5	2520	103.3
NR	100430	SCCDO016.55	CANADA DEL ORO	SOUTH OF PINAL/PIMA COUNTY LINE	323043.5	1104702.5	4600	15.0
NR	100442	SRCHE011.08	CHERRY CREEK	ABOVE CONFLUENCE WITH DEVILS CHASM	334942.2	1105123.1	3190	172.4
NR	100441	SRCHE024.73	CHERRY CREEK	ABOVE CONFLUENCE WITH TURKEY CREEK	340129.7	1105348.5	4390	96.5
NR	100524	BWCTC007.19	COTTONWOOD CANYON	"TRIB TO SMITH CYN, TRIB TO SYCAMORE"	344346.5	1125348.5	4740	
NR	100525	CMCRY000.03	CRYSTAL CREEK	ABOVE COLORADO RIVER CONFLUENCE	360807.5	1121435.5	2360	35.4
NR	100532	CMDEE000.03	DEER CREEK	ABOVE CONFLUENCE WITH COLORADO RIVER	362321.5	1123027.5	1960	
NR	100533	SRDEV000.29	DEVILS CHASM	ABOVE CONFLUENCE WITH CHERRY CREEK	334922.5	1105136.5	3420	2.7
NR	100530	VRDBV007.67	DRY BEAVER CREEK	BELOW CONFLUENCE WITH JACKS CANYON	344422.4	1114616.2	3760	134.3
NR	100551	VREVR000.46	EAST VERDE RIVER	JUST ABOVE CONFLUENCE WITH VERDE RIVER	341708.0	1113938.0	2480	330.4
NR	100550	VREVR008.23	EAST VERDE RIVER	BELOW PINE CREEK CONFLUENCE	341319.4	1112928.9	3320	248.8
NR	100557	VRGAP000.52	GAP CREEK	0.5 MILES ABOVE SALT MINE ROAD	342451.7	1114739.7	3080	10.6
NR	100569	CMHRM001.35	HERMIT CREEK	ABOVE TONTO TRAIL CROSSING	360450.5	1121248.5	2920	9.7
NR	100574	SPHSC006.13	HOT SPRINGS CANYON	BELOW WILDCAT CANYON CONFLUENCE	322114.6	1101602.2	3830	95.1
NR	100761	VRHOU002.75	HOUSTON CREEK	ABOVE FOREST SERVICE ROAD #16 CROSSING	341902.8	1114302.0	2920	9.1
NR	100577	CMKAN000.20	KANAB CREEK	ABOVE COLORADO RIVER CONFLUENCE	362339.5	1123754.5	1880	2311.6

NR	100585	VRLIM000.71	LIME CREEK	1 MI ABV CONFL WITH VERDE BLW HORSESHOE DAM	335917.7	1114519.2	2120	41.3
NR	100586	MGLIO000.16	LION CANYON	ABOVE WEAVER CREEK CONFLUENCE	341014.5	1124135.5	3850	2.3
NR	100578	MGLAS003.16	LITTLE ASH CREEK	NEAR ESTLER PEAK	342301.5	1120130.5	3840	43.7
NR	100594	CMNAN000.15	NANKOWEAP CREEK	ABOVE COLORADO RIVER CONFLUENCE	361818.5	1115135.5	2800	35.3
NR	100602	CMNAT000.34	NATIONAL CREEK	ABOVE COLORADO RIVER CONFLUENCE	361517.5	1125307.5	2120	152.5
NR	100614	VROAK006.49	OAK CREEK	ABOVE PAGE SPRINGS	344604.5	1115334.5	3480	358.8
NR	100612	VROAK010.29	OAK CREEK	AT RED ROCK STATE PARK	344846.4	1114949.8	3840	268.9
NR	100461	VROAK013.11	OAK CREEK	AT CHAVEZ CROSSING	345035.3	1114636.9	4076	249.1
NR	100459	VROAK016.57	OAK CREEK	AT GRASSHOPPER POINT	345310.2	1114355.2	4365	225.4
NR	100623	MGPOL001.41	POLAND CREEK	BELOW DANNY'S LOWER SPRING	341432.5	1121502.5	3080	27.0
NR	100626	VRRED001.97	RED CREEK	ABOVE SECOND ROAD CROSSING	341011.5	1114609.4	2560	19.5
NR	100632	CMRYA000.06	ROYAL ARCH CREEK	ABOVE COLORADO RIVER CONFLUENCE	361150.5	1122700.5	2160	15.4
NR	100635	SCSAB007.56	SABINO CANYON CREEK	ABOVE E. FK SABINO CANYON CONFLUENCE	322204.2	1104651.3	3720	18.2
NR	100642	UGSFR011.68	SAN FRANCISCO RIVER	BELOW SYCAMORE GULCH CONFLUENCE	330814.5	1091642.5	3595	2754.0
NR	100648	CMSPG000.11	SPRING CANYON CREEK	ABOVE COLORADO RIVER CONFLUENCE	360107.5	1132109.5	1520	22.1
NR	100650	VRSPN001.36	SPRING CREEK	"TRIBUTARY TO OAK CREEK, NEAR ROAD CROSSING"	344549.1	1115459.1	3480	70.8
NR	100665	VRTGL000.31	TANGLE CREEK	ABOVE VERDE RIVER CONFLUENCE	340515.2	1114300.0	2080	60.7
NR	100662	CMTAP000.16	TAPEATS CREEK	ABOVE COLORADO RIVER CONFLUENCE	362215.5	1122750.5	2000	84.1

NR	100667	CMTHS000.04	THREE SPRINGS CREEK	ABOVE COLORADO RIVER CONFLUENCE	355307.5	1131830.5	1440	16.6
NR	100668	SRTON025.82	TONTO CREEK	ABOVE GISELA	340739.5	1111506.5	2950	201.2
NR	100678	VRVER036.65	VERDE RIVER	ABOVE SHEEP BRIDGE	340432.9	1114229.7	2040	5738.9
NR	100677	VRVER064.80	VERDE RIVER	AT BEASLEY FLAT RECREATION AREA	342850.5	1114755.5	2940	4863.2
NR	100723	VRVER066.74	VERDE RIVER	ABOVE CONFLUENCE W/ WEST CLEAR CREEK	343024.8	1115012.2	3000	4549.6
NR	100481	VRVER078.76	VERDE RIVER	DS OF OAK CREEK CONFLUENCE	344030.8	1115619.6	3053	4142.0
NR	100482	VRVER084.35	VERDE RIVER	DEADHORSE STATE PARK IN COTTONWOOD	344503.7	1120050.9	3280	3594.8
NR	100680	CMVGR010.55	VIRGIN RIVER	AT LITTLEFIELD	365349.5	1135511.5	1780	
NR	100689	VRWCL002.91	WEST CLEAR CREEK	AT CAMPGROUND	343050.9	1114521.4	3260	260.9
NR	100685	VRWBV003.18	WET BEAVER CREEK	AT MONTEZUMA WELL	343855.8	1114500.1	3520	191.9
NR	100684	VRWBV005.06	WET BEAVER CREEK	AT CAMPGROUND	344005.4	1114250.6	3760	113.0
STRESS	100416	CMBDW000.08	BEAVER DAM WASH	ABOVE CONF WITH VIRGIN RIVER	365344.5	1135515.5	1780	
STRESS	100415	CMBDW000.52	BEAVER DAM WASH	NEAR GOLF COURSE	365357.5	1135546.5	1820	
STRESS	100417	CMBDW006.00	BEAVER DAM WASH	AT WELCOME CREEK	365822.5	1135901.5	2060	
EDW	100424	VRBIT002.64	BITTER CREEK	0.5 MILES BELOW JEROME WWTP	344526.4	1120619.0	4440	0.5
STRESS	100549	VREVR011.19	EAST VERDE RIVER	ABOVE BRUSHY CANYON CONFLUENCE	341712.2	1112304.7	4280	152.2
STRESS	100544	UGEMC011.21	EMIGRANT CANYON	BELOW MAVERICK CANYON CONFLUENCE	320720.3	1092202.0	4840	
STRESS	101221	SRGRE005.20	GREENBACK CREEK	ABOVE DEVIL'S CANYON CONFLUENCE	335036.5	1110914.5	3640	18.6

STRESS	100566	MGHSR059.84	HASSAYAMPA RIVER	BELOW COTTONWOOD CREEK CONFLUENCE	341112.5	1123221.5	3270	303.1
STRESS	100565	MGHSR076.00	HASSAYAMPA RIVER	BELOW BOARD CREEK CONFLUENCE	342515.5	1123128.5	4750	41.0
STRESS	100568	CMHAV000.30	HAVASU CREEK	ABOVE COLORADO RIVER CONFLUENCE	361815.5	1124529.5	1840	2965.9
STRESS	100583	LCLCR000.21	LITTLE COLORADO RIVER	ABOVE COLORADO RIVER CONFLUENCE	361130.5	1114730.5	2760	21904.0
STRESS	100591	CMMAT000.03	MATKATAMIBA CREEK	ABOVE COLORADO RIVER CONFLUENCE	362037.5	1124017.5	1900	33.0
STRESS	100613	VROAK005.91	OAK CREEK	BELOW PAGE SPRINGS	344532.5	1115335.5	3460	360.2
STRESS	100617	CMPAR001.01	PARIA RIVER	ABV COLORADO RIVER CONFLUENCE	365221.5	1113600.5	3120	1258.9
EDW	100622	SRPNL012.46	PINAL CREEK	"ABOVE RADIUM, BELOW IRENE GULCH"	332647.5	1104907.5	3275	
EDW	100624	MGQEN028.97	QUEEN CREEK	ABOVE BOYCE-THOMPSON ARBORETUM	331638.5	1110904.5	2440	
STRESS	100636	SRSAL014.92	SALOME CREEK	BELOW LITTLE TURKEY CREEK CONFLUENCE	335445.8	1110223.2	4820	19.2
EDW	100646	MGSLR000.54	SALT RIVER	ABOVE GILA R CONFL. AT 107TH AVE	332252.5	1121730.5	935	
EDW	100638	SCSCR022.85	SANTA CRUZ R. @ RANCHO SANTA CRUZ	AT RANCHO SANTA CRUZ; ABV JOSEPHINE CANYON	323043.5	1110215.5	3280	
STRESS	100637	SCSCR099.40	SANTA CRUZ RIVER	BELOW USGS GAGING STATION @ LOCHIEL	312057.5	1103524.5	4630	97.6
STRESS	100587	MGTRK000.91	TURKEY CREEK	"AT SPRING, BELOW GOLDEN TURKEY MINE"	341505.5	1121229.5	2880	
STRESS	100679	CMVGR017.14	VIRGIN RIVER	AT REST STOP	365708.5	1134720.5	2150	

Appendix B: Cold water Site List used to develop the Arizona Cold Water Index of Biological Integrity (1992-1998)

Site Class	ADEQ Site Number	Station ID-Vector method	Waterbody Name	Location	LAT_DMS	LONG_DMS	Elevation	Catchment Area mi2
R	100410	LCBRB003.84	BARBERSHOP CANYON CREEK	BELOW MERRITT DRAW CONFLUENCE	342939.9	1110954.7	6950	7.6
R	100522	UGCMB002.16	CAMPBELL BLUE CREEK	ABOVE CONFLUENCE WITH K E CANYON	334419.5	1090547.5	6670	47.3
R	100428	SPCRC008.61	CARR CANYON	NEAR HEADWATERS	312536.6	1101823.7	7225	
R		UGCAV009.86	Cave Creek	Cave Crk abv Herb Martyr Campground				
R	100523	UGCOL002.49	COLEMAN CREEK	BELOW TURKEY CREEK CONFLUENCE	334617.3	1091112.3	7850	9.4
R	100521	SRCKN001.23	CONKLIN CREEK	ABOVE FOREST SERVICE ROAD #25	334054.5	1092636.5	7200	7.3
R	100545	UGETK007.70	EAST TURKEY CREEK	ABOVE FOREST ROAD 42	315431.1	1091509.3	6520	2.0
R	100546	VREVR018.56	EAST VERDE RIVER	BELOW WASHINGTON PARK	342515.9	1111545.4	5840	2.3
R	100542	VRELL004.47	ELLISON CREEK	HEADWATERS	342243.9	1111029.5	6160	1.8
R	100720	UGFRY007.00	FRYE CANYON CREEK	AT FIRST CROSSING OF FS TRAIL #36	324436.5	1095018.5	5800	4.0
R	100584	LCLIL001.66	LILY CREEK	BELOW FORK; BELOW FOREST ROAD #275	335837.5	1090532.5	8620	0.6
R	100580	LCLCR173.84	LITTLE COLORADO RIVER	ABV S. FK LITTLE COLORADO RIVER CONFLUENCE	340440.3	1092534.2	7490	68.1
R	100589	LCMAM001.73	MAMIE CREEK	BELOW FOREST SERVICE ROAD #275	335801.5	1090455.2	8590	2.1
R	100590	UGMRW007.98	MARIJILDA CREEK	ABOVE TRAIL #308 CROSSING	324101.5	1094842.5	5520	4.9
R	100592	SPMLC008.64	MILLER CANYON	NEAR HEADWATERS	312417.5	1101705.5	6750	

R	100593	LCMIN014.01	MINERAL CREEK	ABOVE FOREST SERVICE ROAD #404	341047.7	1093705.6	8070	6.3
R	100606	CMNCA020.06	NORTH CANYON CREEK	BELOW NORTH CANYON SPRING	362429.5	1120440.5	7440	11.0
R	100605	SRNBE000.54	N FORK BEAR WALLOW CREEK	ABOVE S. FK BEAR WALLOW CRK CONFLUENCE	333546.8	1092559.2	7740	6.2
R	100615	LCPAD000.85	PADDY CREEK	APPX 1.2 MILES ABV NUTRIOSO CRK CONFLUENCE	335504.5	1090902.5	8485	4.4
R	100621	VRPIE013.89	PINE CREEK	NEAR HEADWATERS	342515.6	1112624.7	5760	6.9
R	100625	SPRMC007.43	RAMSEY CANYON	ABOVE THE NATURE CONSERVANCY BUILDINGS	312613.7	1101906.9	6175	2.8
R	100629	SRRES000.30	RESERVATION CREEK	ABOVE BLACK RIVER CONFLUENCE	334156.9	1092836.3	6790	22.8
R	100634	LCRUD005.17	RUDD CREEK	ABOVE BENTON CREEK CONFLUENCE	340039.5	1091651.5	8100	5.1
R		UGSCV	S Fork Cave Creek	S. Fk Cave Crk abv S. Fk pinic area				
R	100644	LCSLR001.29	S FORK LITTLE COLORADO RIVER	ABOVE SOUTH FORK CAMPGROUND	340414.5	1092434.6	7620	23.2
R	100682	WPWRC000.31	WARD CANYON	ABOVE SAULSBURY CANYON CONFLUENCE	315153.7	1091945.2	6260	3.0
R	100205	VRWCL016.84	WEST CLEAR CREEK	"AT MAXWELL TRAIL, UPPER"	343312.5	1112427.5	5985	135.3
R	100691	SRWFB003.73	WEST FORK BLACK RIVER	ABOVE WEST FORK CAMPGROUND	334738.8	1092521.9	7800	34.8
R	100695	LCWLR001.08	W FORK LITTLE COLORADO RIVER	ABOVE GOVERNMENT SPRINGS	335921.2	1092752.7	8550	11.1
R	100694	LCWLR004.09	W FORK LITTLE COLORADO RIVER	ABOVE MOUNT BALDY WILDERNESS BOUNDARY	335722.1	1093106.4	9240	5.5
R	100696	SRWRK005.34	WORKMAN CREEK	BELOW WORKMAN CREEK FALLS	334925.5	1105618.5	6160	2.8
NR	100189	VRAPA000.01	Apache Creek	near Walnut Creek			5231.9	10.7

NR	100715	VRAPA002.46	APACHE CREEK	ABOVE HUNT TANK	345330.8	1125258.9	5360	5.5
NR	100190	VRAPA005.22	Apache Creek	below Apache Springs			6202.9	1.0
NR	100411	LCBRB000.18	BARBERSHOP CANYON CREEK	ABOVE EAST CLEAR CREEK CONFLUENCE	343250.5	1110942.5	6540	20.7
NR	100419	UGBLR033.04	BLUE RIVER	BELOW JACKSON BOX (UPPER)	334104.0	1090456.8	6110	115.2
NR	100414	LCBCK003.20	BUCK SPRINGS CANYON CREEK	OUTSIDE EXCLOSURE (OF CATTLE AND ELK)	342637.6	1110819.9	7480	
NR	100413	LCBCK003.81	BUCK SPRINGS CANYON CREEK	INSIDE EXCLOSURE (OF CATTLE AND ELK)	342604.0	1110832.3	7520	
NR	100528	SRCYN031.50	CANYON CREEK	ABOVE VALENTINE CANYON	341529.9	1104742.0	6270	28.7
NR		UGCAV006.55	Cave Creek	Cave Crk blw Idlewild Campground				
NR		UGCAV007.46	Cave Creek	Cave Crk blw conf w/S. Fk Cave Crk				
NR		UGCAV007.70	Cave Creek	Cave Crk abv conf w/S. Fk Cave Crk				
NR		UGCAV008.49	Cave Creek	Cave Crk abv the Southwest Research Stn				
NR	100445	LCCHC037.39	CHEVELON CANYON CREEK	AT TELEPHONE RIDGE	342625.5	1105022.5	6470	59.2
NR	100537	LCECL007.86	EAST CLEAR CREEK	ABOVE CONFLUENCE WITH YEAGER CANYON	343359.5	1110848.5	6450	104.2
NR	100539	SREFB005.46	EAST FORK BLACK RIVER	ABOVE DIAMOND ROCK CAMPGROUND	334919.5	1091746.5	7920	102.0
NR	100762	LCELR005.60	E FORK LITTLE COLORADO RIVER	NEAR MT. BALDY WILDERNESS BOUNDARY	335534.5	1092948.5	9440	1.6
NR	100548	VREVR015.85	EAST VERDE RIVER	BELOW ELLISON CREEK CONFLUENCE	342139.5	1111647.5	4920	71.2
NR	100560	UGGRA000.65	GRANT CREEK	ABOVE BLUE RIVER CONFLUENCE	333441.5	1091116.5	5580	18.5
NR	100579	UGLAN000.60	LANPHIER CANYON	ABOVE FOREST SERVICE TRAIL #51 CROSSING	333511.1	1090744.6	5725	10.4

NR	100581	LCLCR173.85	LITTLE COLORADO RIVER	BLW S. FK LITTLE COLORADO RIVER CONFLUENCE	340511.5	1092409.5	7305	94.6
NR	100608	VROAK023.21	OAK CREEK	BELOW CAVE SPRING CAMPGROUND	345934.5	1114410.5	5400	91.0
NR		UGSCV000.12	S Fork Cave Creek	S. Fk Cave Crk abv conf w/Cave Crk				
NR	100640	UGSCV002.45	S FORK CAVE CREEK	ABOVE SOUTH FORK CAMPGROUND	315113.5	1091132.5	5560	11.1
NR	100690	VRWEB006.03	WEBBER CREEK	BELOW GERONIMO BOY SCOUT CAMP	342357.5	1112151.0	5380	10.3
NR	100687	VRWCL012.50	WEST CLEAR CREEK	AT CALLAWAY BUTTE	343339.5	1113130.6	5000	212.3
S	100444	LCCHC038.75	CHEVELON CANYON CREEK	ABOVE CONFLUENCE WITH LONG TOM CANYON	342519.5	1105110.5	6535	46.9
S	100443	LCCHC040.40	CHEVELON CANYON CREEK	AT CHEVELON RIDGE	342358.5	1105200.5	6670	44.0
S	100535	UGEAG035.99	EAGLE CREEK	ABOVE HONEYMOON CAMPGROUND	332846.0	1092830.2	5435	101.1
S	100538	LCECL004.07	EAST CLEAR CREEK	ABOVE MACKS CROSSING	343710.5	1110534.5	6265	132.6
S	100543	VRELL000.12	ELLISON CREEK	ABOVE CONFLUENCE WITH EAST VERDE RIVER	342106.5	1111639.8	5000	42.7
S	100582	LCLCR171.07	LITTLE COLORADO RIVER	BELOW NUTRIOSO CREEK CONFLUENCE	341033.5	1091806.5	6770	353.3
S	100627	LCRDF006.78	RIO DE FLAG	BELOW FLAGSTAFF WWTP	351226.5	1113433.5	6760	
S	100633	RMRUC005.85	RUCKER CANYON CREEK	ABOVE BEAR CANYON CONFLUENCE	314707.4	1091733.8	6220	7.2
S	100681	VRWAL011.07	WALNUT CREEK	ABOVE FOREST SEVICE ROAD #95	345512.3	1125052.0	5160	27.0