REVISED OCTOBER 30, 2018
REVISED 5/98
MI/DEQ/SWQ-96/068

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
SURFACE WATER QUALITY DIVISION
JUNE 1996

STAFF REPORT

UPDATE OF GLEAS PROCEDURE 51 METRIC SCORING AND INTERPRETATION

Great Lakes and Environmental Assessment Section (GLEAS) Procedure 51 describes qualitative biological and habitat survey protocols for wadable streams. This report serves to document the scoring and interpretation of the results from Procedure 51 sampling for biological communities.

GENERAL CONCEPT

The general premise that is used in the interpretation of the biological sampling results is that the professional biologists can recognize excellent or poor fish or macroinvertebrate communities, and that these communities can be described by a set of metrics. The metric scores will change as the quality of the community changes, with the excellent distinctly different from the poor community. This general premise was then used to describe the excellent communities, using the variability among the excellent communities to establish appropriate scoring levels.

SCORING

A scale of +1, 0, -1 was used to score each metric. This scale was chosen to facilitate better and rapid communication of results. The scores were based on the following scale:

+1	=	Community performing better than the average condition found at the excellent sites;
0	=	Community performing between the average condition and (minus) 2 standard deviations from the average condition found at the excellent site;
-1	=	Community performing outside of (minus) 2 standard deviations from the average condition found at the excellent sites.

Each metric for the fish and macroinvertebrate communities was evaluated for scoring based on these criteria. The number of taxa metrics were found to vary with stream width at small widths (less than 30 feet wide). Therefore, each number of taxa metric was plotted following the Maximum Species Richness technique (Karr, 1981) to determine the stream width at which the line slope become flat (zero). After this point, all excellent sites were grouped for evaluation.

FISH METRICS

Fish metrics were scored only for warmwater streams. Coldwater designated streams were not scored because the available metrics do not adequately describe the variety of streams presently designated as coldwater in Michigan. The interpretation of coldwater fish results will be discussed later.

Four of Michigan's five Ecoregions were scored for warmwater fish. The fifth Ecoregion (North Central Hardwoods) was not scored due to a lack of warmwater sites. The results of this scoring are presented in Table 1 and Figures 1-19. The number of stations used is indicated in Table 2.

There were some modifications to the general scoring. These modifications were:

1. For fish metrics 2, 3 and 4 (Darters, Sunfish and Suckers), the data distribution was skewed by the few number of species found. Therefore, the mean and standard deviation approach was determined to not be appropriate. The scoring for these metrics was done by dividing the Maximum Species Richness line into thirds. This is similar to the approach used by Karr (1981) and Lyons (1992).

2. For metric 5 (# Intolerant taxa), the HELP and ECB Ecoregion scores were modified to be the same as the SMNITP Ecoregion. This was because of two factors: 1) all the other scores for the number of taxa metrics were virtually the same as SMNITP; and 2) using the Maximum Species Richness line divided into thirds yielded the same result.

3. For a few of the percentile scores, modifications were made when 2 standard deviations from the mean of the excellent sites fell outside the 0-100% range. This modification was to put these ranges at 1% or 99%. This was done for metric 9 (% Piscivores), metric 8 (% Insectivores -- NLF, ECB), metric 10 (Simple Lithophilic Spawners -- HELP) and metric 6 (%Tolerants -- ECB).

MACROINVERTEBRATE METRICS

Macroinvertebrate metrics were scored for all five Ecoregions. Stream types (warmwater and coldwater) were found to be similar and combined for scoring within each Ecoregion. The results of this scoring are presented in Table 3 and Figures 20-34. The number of stations used in developing these metrics are shown in Table 4.

There were some modifications to the general scoring process. These modifications were in the percentile scores when 2 standard deviations from the mean of the excellent sites was less than zero. In two instances this occurred, and the score was set at 1% -- in metric 5 (% Mayfly -- ECB) and metric 6 (% Caddisfly -- ECB).

INTERPRETATION OF SCORES

Each site can now be scored using the metrics and the scoring scale developed for fish and macroinvertebrates. There are 10 fish metrics, therefore the scoring will range from +10 to -10 for the fish community. There are 9 macroinvertebrate metrics, therefore the scoring will range from +9 to -9 for the macroinvertebrate community.

The interpretation of the score involves determining whether the site performs like excellent sites, poor sites, or between excellent and poor, wich was termed acceptable. If a site performs in most metrics like an excellent site, it will be classified as an excellent site. Similarly, if a site performs in most metrics substantially different than an excellent site, it will be classified as a poor site. This results in scores of +5 or higher being classified as excellent, and scores of -5 or lower being classified as poor. Acceptable sites, those streams meeting Water Quality Standards, are scored between excellent and poor, in the range of +4 to -4. A site with a score of 0 is exactly neutral, with no tendency toward excellent or poor. A site with a positive score of +4 or less is tending toward excellent. A site with a negative score of -1 to -4 is tending toward poor.

For the fish community, there are some additional considerations when interpreting the results. First, for designated coldwater streams, the metrics developed do not apply to these streams. Instead, to determine if the coldwater designated use is being met, the presence of salmonids at 1% or greater in the fish community will be interpreted as meeting the coldwater designated use. For determining stream quality in these cases, the macroinvertebrate community will be used to determine this.

Second, as described in Procedure 51, there are two overriding factors which will immediately classify the fish community as poor. These factors include the inability to collect over 50 fish at a site, or the presence of anomalies at a rate greater than 2% of the fish community.

REFERENCES

Karr, J.R. 1981. Assessment of biotic integrity using fish communities. Fisheries 6:21-27.

Lyons, J. 1992. Using the index of biotic integirty (IBI) to measure environmental quality in warmwater streams of Wisconsin. U.S. Forest Service General Technical Report. NC-149.

Report by: William Creal
Scott Hanshue
Sandra Kosek
Mark Oemke
Mike Walterhouse
Great Lakes and Environmental Assessment Section
Surface Water Quality Division

Table 1. Summary of Warmwater Fish Metric Scores for Wadable Streams

Ecoregion: SMNITP

Metric	Stream Width (ft)	+1	0	-1
1. Total Taxa	<15	>.92w	0.6w-0.92w	<0.60w
	≥15	>13	10-13	<10
2. Darter Taxa	<17	>.23w	.11w-.23w	<.11w
	≥17	>3	2-3	<2
3. Sunfish Taxa	<15	>.22w	.11w-.22w	<.11w
	≥15	>3	2-3	<2
4. Sucker Taxa	<18	>.15w	.074w-.15w	<.074w
	≥18	>2	2	<2
5. Intolerant Taxa	<21	>.23w	.14w-.23w	<.14w
	≥21	>4	3-4	<3
6. % Tolerant	All	<20	20-53	>53
7. % Omnivore	All	<16	16-46	>46
8. % Insectivore	All	>64	64-31	<31
9. % Piscivore	All	>14	14-1	<1
10. % Simple Lithophilic Spawners	All	>41	41-2	<2

w = average stream width in feet

Table 1. Continued

Ecoregion: NLF

Metric	Stream Width (ft)	+1	0	-1
1. Total Taxa	<11	>1.2w	0.76w-1.2w	<.76w
	≥11	>12	8-12	<8
2. Darter Taxa	<10	>.27w	.14w-.27w	<.14w
	≥10	>2	2	<2
3. Sunfish Taxa	All	>0	--	0
4. Sucker Taxa	<13	>.1w	.05w-.1w	<.05w
	≥13	>1	1	0
5. Intolerant Taxa	<13	>.24w	.16w-.24w	<.16w
	≥13	>3	2-3	<2
6. % Tolerant	All	<38	38-90	>90
7. % Omnivore	All	<29	29-83	>83
8. % Insectivore	All	>50	50-1	<1
9. % Piscivore	All	>10	10-1	<1
10. % Simple Lithophilic Spawners	All	>41	41-2	<2

w = average stream width in feet

Table 1. Continued

Ecoregion: HELP

Metric	Stream Width (ft)	+1	0	-1
1. Total Taxa	<12	>1.2w	.76w-1.2w	<.76w
	≥12	>14	10-14	<10
2. Darter Taxa	<15	>.22w	.11w-.22w	<.11w
	≥15	>3	2-3	<2
3. Sunfish Taxa	<20	>.17w	.085w-.17w	<.085w
	≥20	>3	2-3	<2
4. Sucker Taxa	<15	>.14w	.066w-.14w	<.066w
	≥15	>2	2	<2
5. Intolerant Taxa	<24	>.19w	.096w-.19w	<.096w
	≥24	>4	3-4	<3
6. % Tolerant	All	<39	39-75	>75
7. % Omnivore	All	<31	31-72	>72
8. % Insectivore	All	>62	62-15	<315
9. % Piscivore	All	>3	3-1	<1
10. % Simple Lithophilic Spawners	All	>47	47-1	<1

w = average stream width in feet

Table 1. Continued

Ecoregion: ECB

Metric	Stream Width (ft)	+1	0	-1
1. Total Taxa	<6	>2.2w	1.1w-2.2w	<1.1w
	≥6	>13	7-13	<7
2. Darter Taxa	<9	>.44w	.22w-.44w	<.22w
	≥9	>3	2-3	<2
3. Sunfish Taxa	<12	>.22w	.11w-.22w	<.11w
	≥12	>2	2	<2
4. Sucker Taxa	<10	>.2 w	.1w-.2w	<.1w
	≥10	>2	2	<2
5. Intolerant Taxa	<11	>.36w	.27w-.36w	<.27w
	≥11	>4	3-4	<3
6. % Tolerant	All	<53	53-99	>99
7. % Omnivore	All	<36	36-88	>88
8. % Insectivore	All	>47	47-1	<1
9. % Piscivore	All	>5	5-1	<1
10. % Simple Lithophilic Spawners	All	>33	33-9	<9

w = average stream width in feet

Table 2. Number of stations used in developing fish metrics. Stations are from 1990-1994 database.

Ecoregion:	SMNITP	NLF	HELP	ECB	NCH	Total
Excellent Sites:	24	7	7	7	---	45
Other Sites:	151	15	53	18	---	237
Total:	175	22	60	25	---	282

Table 3. Summary of Invertebrate Metric Scores for Wadable Streams.

Ecoregion: SMNITP

Metric	Stream Width (ft)	+1	0	-1
1. Total Taxa	<7	>3.3w	1.7w-3.3w	<1.7w
	≥7	>24	12-24	<12
2. Mayfly Taxa	<12	>.3w	.1w-.3w	<.1w
	≥12	>3	2-3	<2
3. Caddisfly Taxa	<8	>.6w	.21w-.6w	<.21w
	≥8	>4	2-4	<2
4. Stonefly Taxa	All	>0	--	0
5. % Mayfly	All	>18	18-3	<3
6. % Caddisfly	All	>28	28-4	<4
7. % Dominance	All	<20	20-37	>37
8. % Isopod, Snail, Leech	All	<4	4-10	>10
9. % Surface Dependent	All	<7	7-19	>19

w = average stream width in feet

Table 3. Continued

Ecoregion: HELP

Metric	Stream Width (ft)	+1	0	-1
1. Total Taxa	<14	>2.3w	1.3w-2.3w	<1.3w
	≥14	>31	18-31	<18
2. Mayfly Taxa	<27	>.14w	.09w-.14w	<.09w
	≥27	>3	2-3	<2
3. Caddisfly Taxa	<14	>.29w	.14w-.29w	<.14w
	≥14	>3	2-3	<2
4. Stonefly Taxa	All	>0	--	0
5. % Mayfly	All	>23	23-15	<15
6. % Caddisfly	All	>22	22-3	<3
7. % Dominance	All	<16	16-22	>22
8. % Isopod, Snail, Leech	All	<6	6-13	>13
9. % Surface Dependent	All	<10	10-23	>23

w = average stream width in feet

Table 3. Continued

Ecoregion: NLF

Metric	Stream Width (ft)	+1	0	-1
1. Total Taxa	<10	>2.7w	1.1w-2.7w	<1.1w
	≥10	>27	11-27	<11
2. Mayfly Taxa	<11	>.42w	.18w-.42w	<.18w
	≥11	>4	3-4	<3
3. Caddisfly Taxa	<10	>0.6w	0.2w-0.6w	<0.2w
	≥10	>5	3-5	<3
4. Stonefly Taxa	<13	0.15w	0.08w-0.15w	<0.08w
	≥13	>1	1	0
5. % Mayfly	All	>21	21-3	<3
6. % Caddisfly	All	>29	29-3	<3
7. % Dominance	All	<17	17-27	>27
8. % Isopod, Snail, Leech	All	<4	4-13	>13
9. % Surface Dependent	All	<5	5-13	>13

w = average stream width in feet

Table 3. Continued

Ecoregion: NCH

Metric	Stream Width (ft)	+1	0	-1
1. Total Taxa	<10	>2.2w	1.5w-2.2w	<1.5w
	≥13	>22	15-22	<15
2. Mayfly Taxa	<11	>.39w	0.14w-.39w	<.14w
	≥11	>4	2-4	<2
3. Caddisfly Taxa	<10	>.54w	.22w-.54w	<.22w
	≥10	>5	3-5	<3
4. Stonefly Taxa	All	>1	1	0
5. % Mayfly	All	>30	10-30	<10
6. % Caddisfly	All	>41	10-41	<10
7. % Dominance	All	<23	23-37	>37
8. % Isopod, Snail, Leech	All	<1	1-2	>2
9. % Surface Dependent	All	<1	1-2	>2

w = average stream width in feet

Table 3. Continued

Ecoregion: ECB

Metric	Stream Width (ft)	+1	0	-1
1. Total Taxa	<5	>3.7w	1.9w-3.7w	<1.9w
	≥5	>18	10-18	<10
2. Mayfly Taxa	<12	>.26w	.10w-.26w	<.10w
	≥12	3	2-3	<2
3. Caddisfly Taxa	<12	>.3w	.11w-.3w	<.11w
	≥12	3	2-3	<2
4. Stonefly Taxa	All	>0	---	0
5. % Mayfly	All	>13	13-1	<1
6. % Caddisfly	All	>24	24-1	<1
7. % Dominance	All	<39	39-77	>77
8. % Isopod, Snail, Leech	All	<3	3-13	>13
9. % Surface Dependent	All	<12	12-26	>26

w = average stream width in feet

Table 4. Number of stations used in developing invertebrate metrics. Stations are from 1990-1994 database.

Ecoregion:	SMNITP	NLF	HELP	ECB	NCH	Total
Excellent:	39	12	8	7	7	73
Other:	352	71	89	25	50	587
Total:	391	83	97	32	57	660

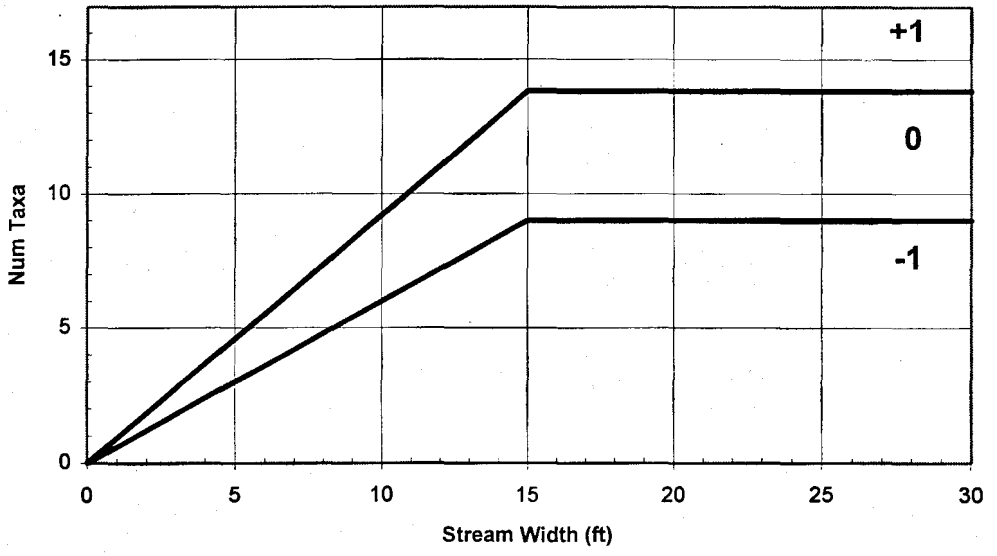

Figure 1: Scoring for Total Number of Fish Taxa, SMNITP Ecoregion.

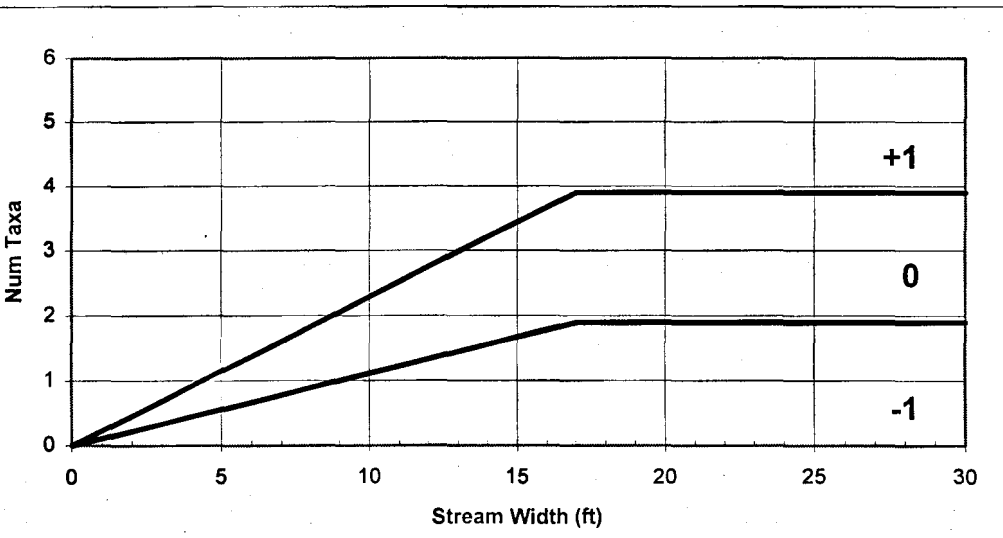

Figure 2: Scoring for Number of Darter Taxa, SMNITP Ecoregion.

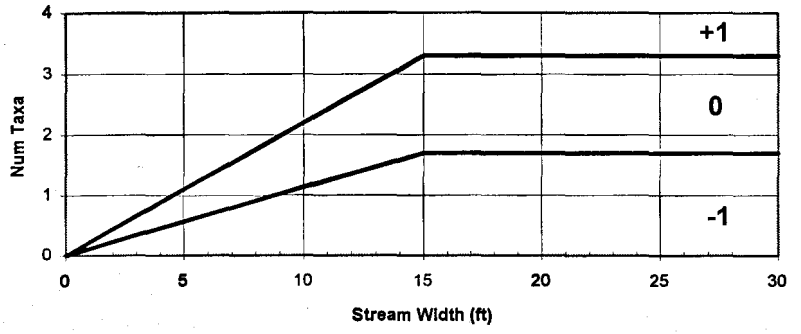

Figure 3: Scoring for Number of Sunfish Taxa, SMNITP Ecoregion.

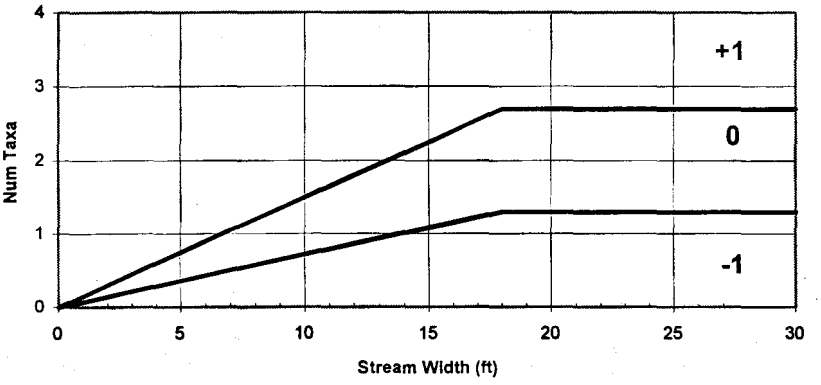

Figure 4: Scoring for Number of Sucker Taxa, SMNITP Ecoregion.

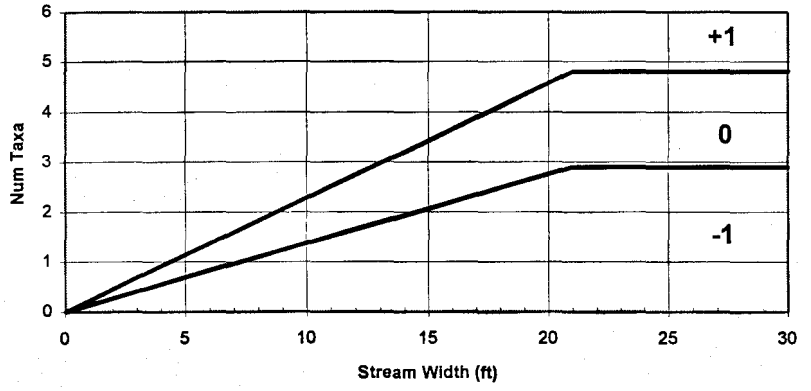

Figure 5: Scoring for Number of Intolerant Taxa, SMNITP Ecoregion.

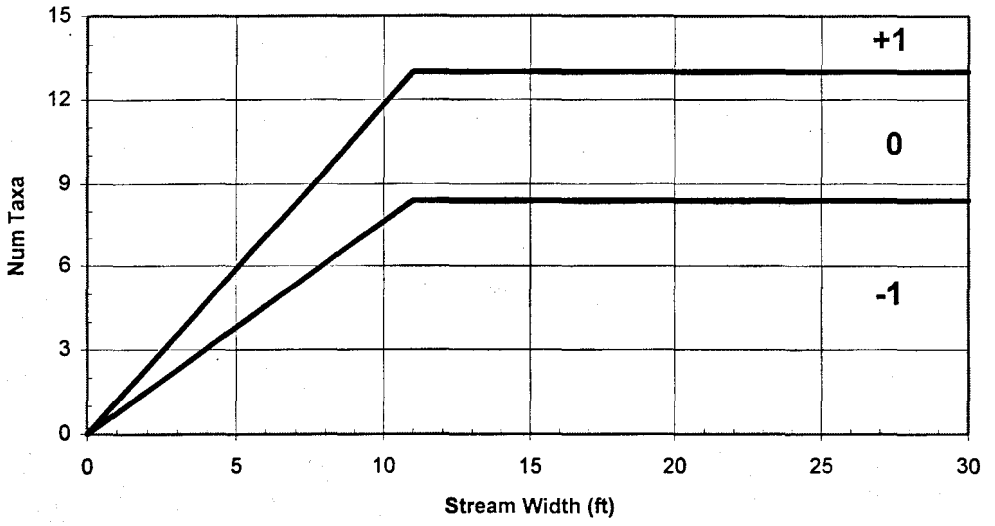

Figure 6: Scoring for Total Number of Fish Taxa, NLAF Ecoregion.

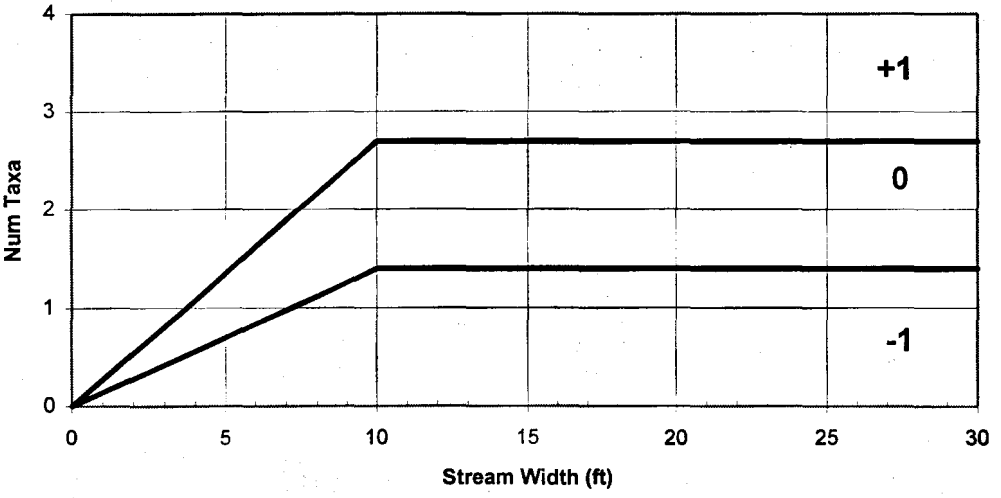

Figure 7: Scoring for Number of Darter Taxa, NLAF Ecoregion.

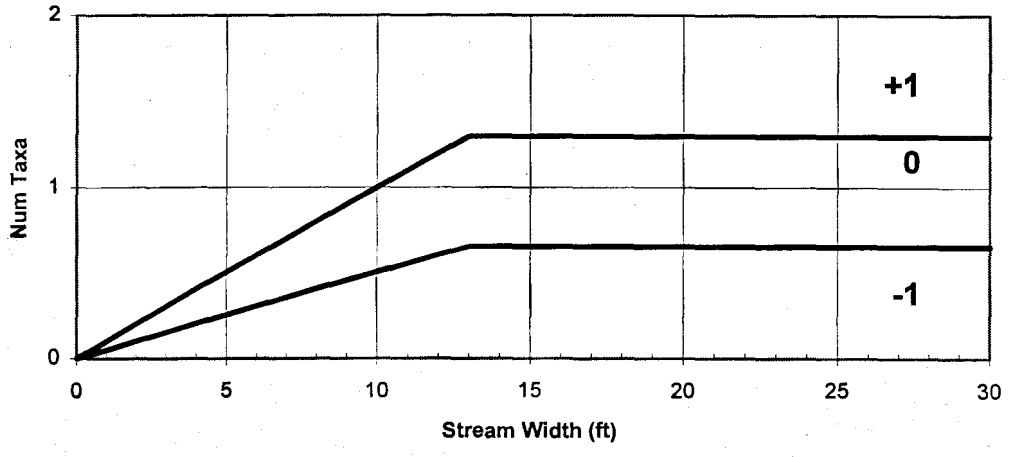

Figure 8: Scoring for Number of Sucker Taxa, NLAF Ecoregion.

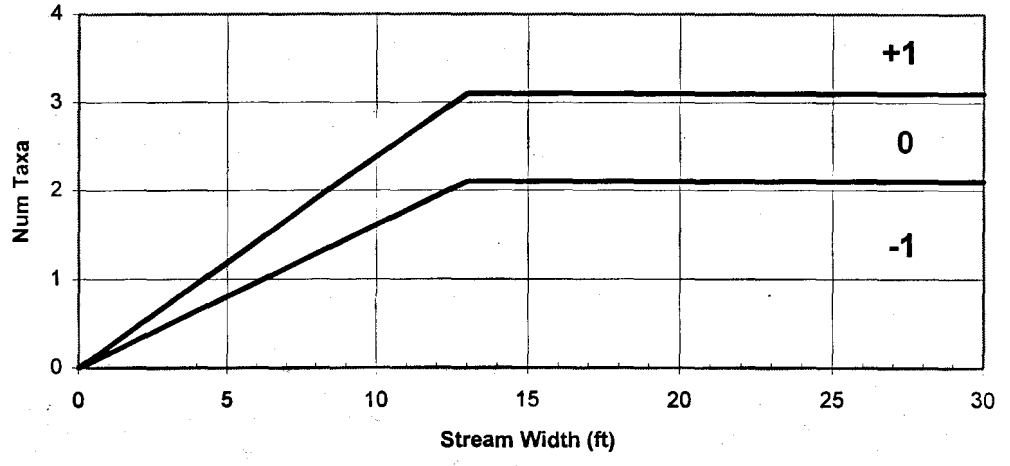

Figure 9:Scoring for Number of Intolerant Taxa, NLAF Ecoregion.

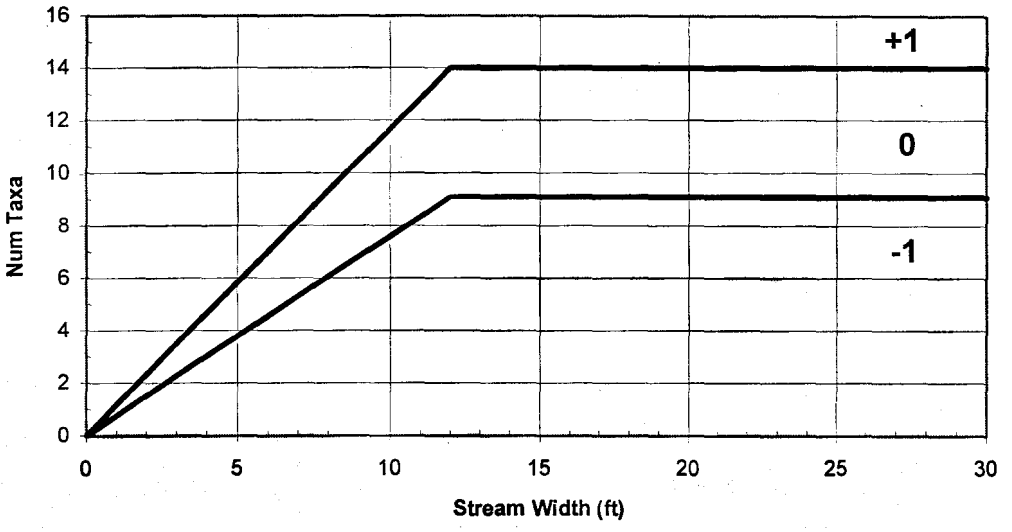

Figure 10: Scoring for Total Number of Fish Taxa, HELP Ecoregion.

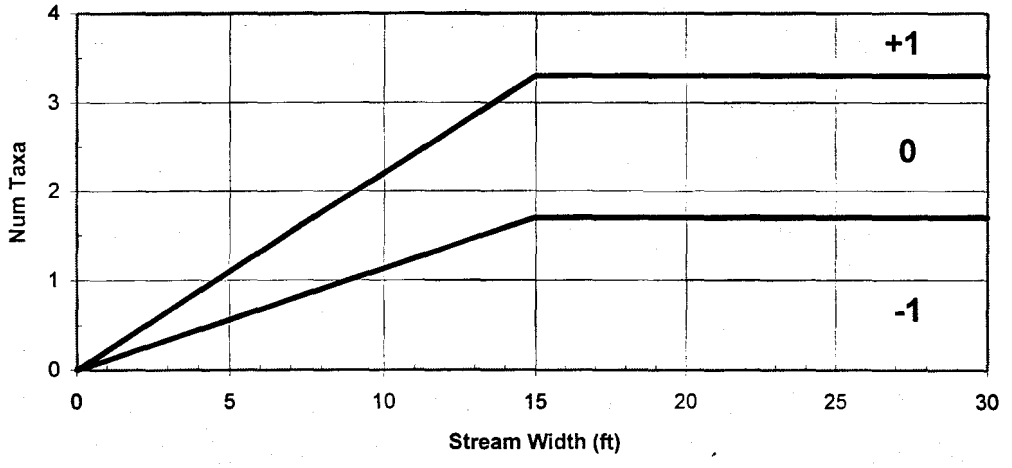

Figure 11: Scoring for Number of Darter Taxa, HELP Ecoregion.

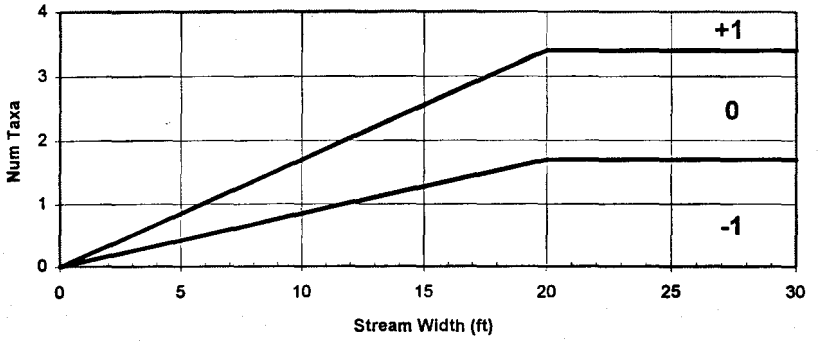

Figure 12: Scoring for Number of Sunfish Taxa, HELP Ecoregion.

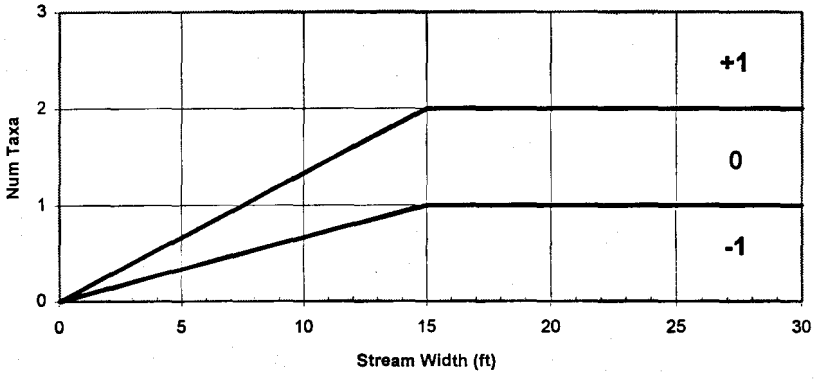

Figure 13: Scoring for Number of Sucker Taxa, HELP Ecoregion.

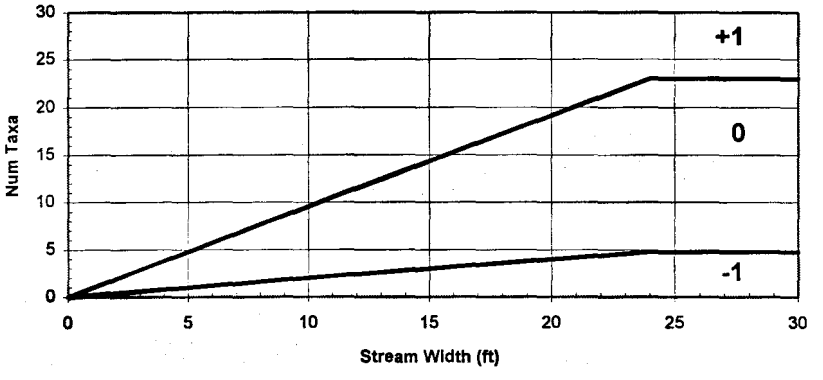

Figure 14: Scoring for Number of Intolerant Taxa, HELP Ecoregion.

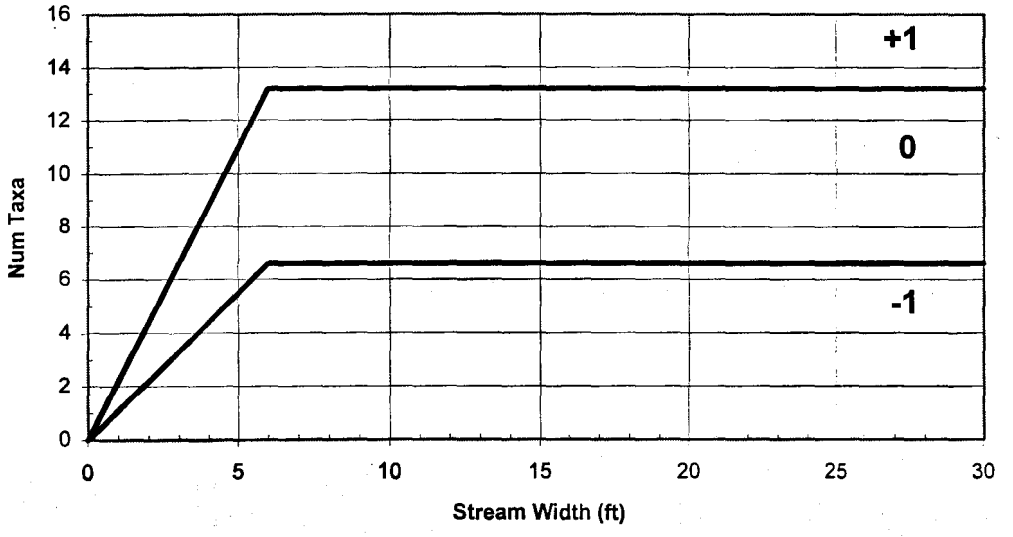

Figure 15: Scoring for Total Number of Fish Taxa, ECBP Ecoregion.

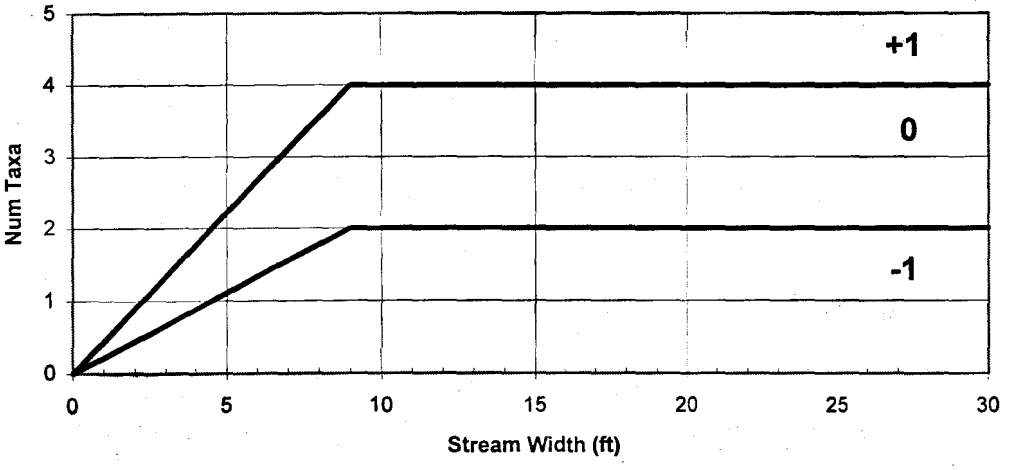

Figure 16: Scoring for Total Number of Darter Taxa, ECBP Ecoregion.

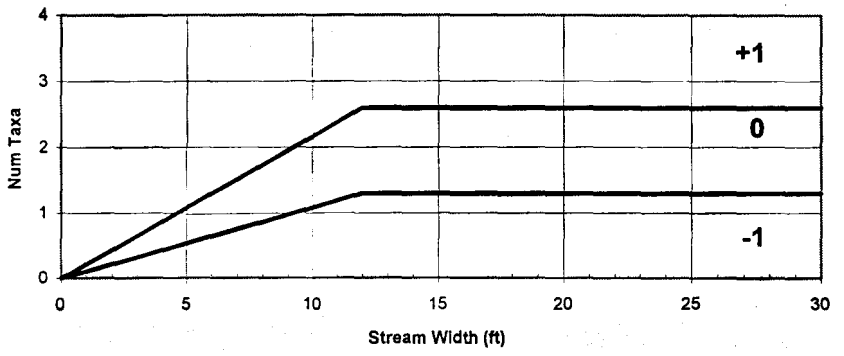

Figure 17: Scoring for Number of Sunfish Taxa, ECBP Ecoregion.

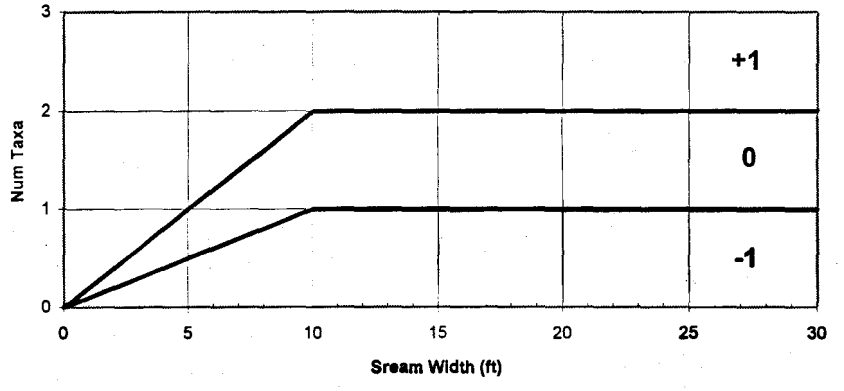

Figure 18: Scoring for Number of Sucker Taxa, ECBP Ecoregion.

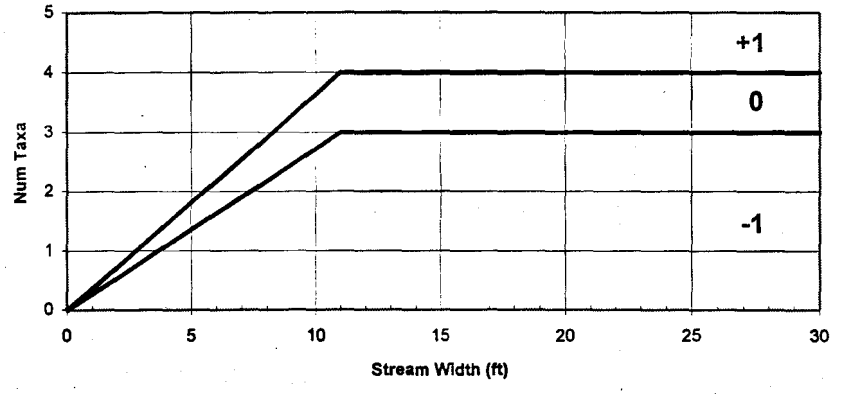

Figure 19: Scoring for Number of Intolerant Taxa, ECBP Ecoregion.

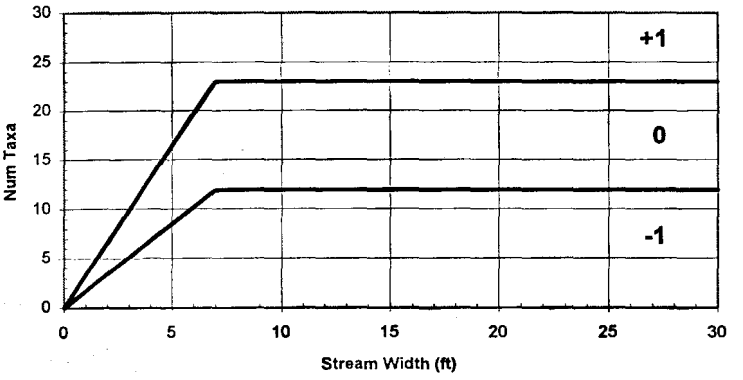

Figure 20: Scoring for Total Number of Macroinvertebrate Taxa, SMNITP Ecoregion.

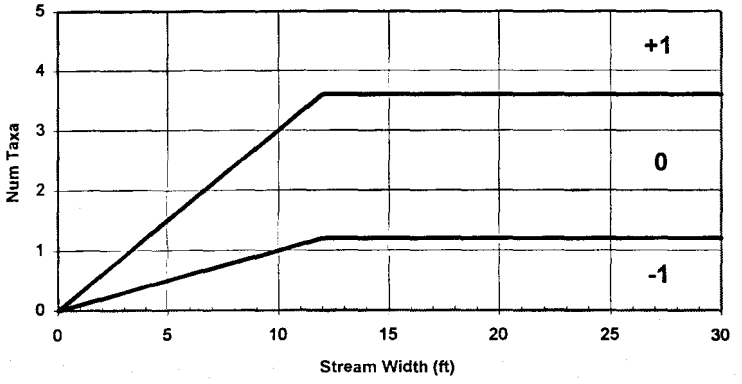

Figure 21: Scoring for Number of Mayfly Taxa, SMNITP Ecoregion.

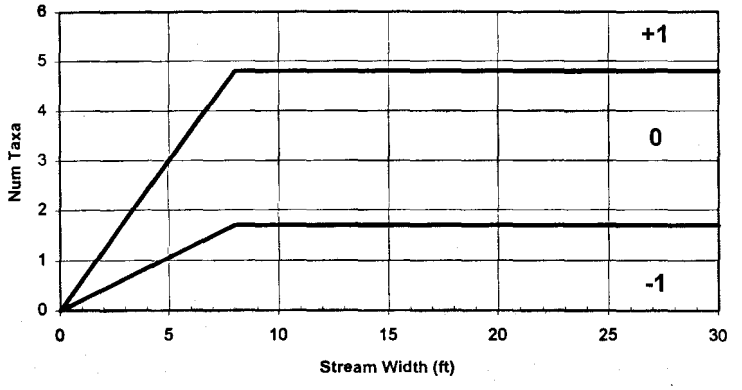

Figure 22: Scoring for Number of Caddisfly Taxa, SMNITP Ecoregion.

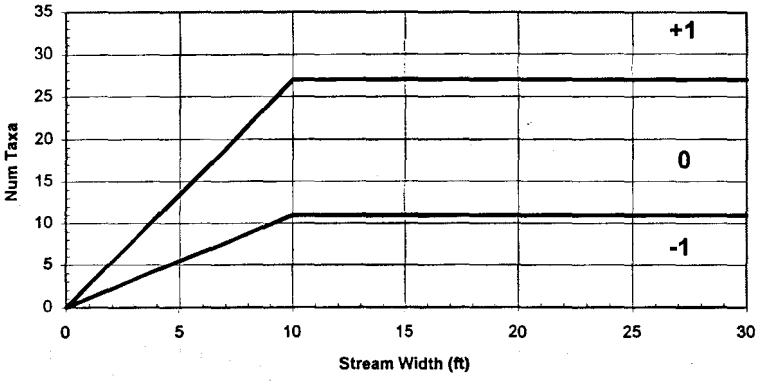

Figure 23: Scoring for Total Number of Macroinvertebrate Taxa, NLAF Ecoregion.

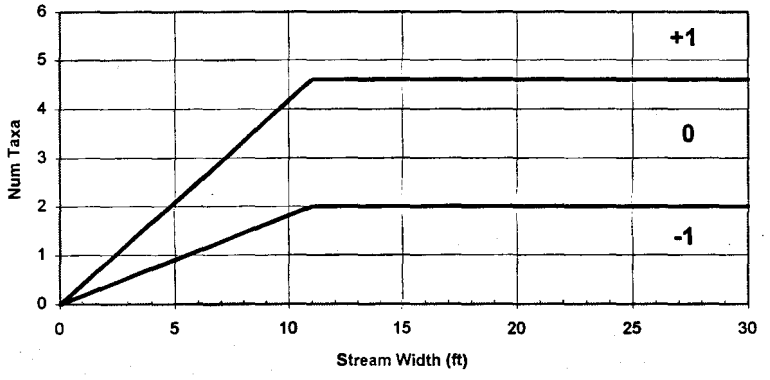

Figure 24: Scoring for Number of Mayfly Taxa, NLAF Ecoregion.

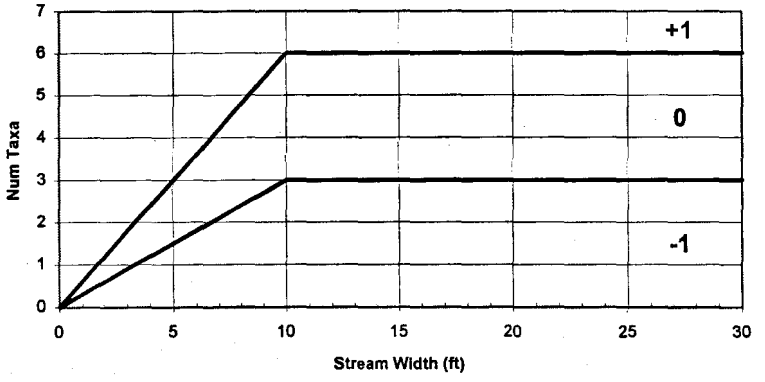

Figure 25: Scoring for Number of Caddisfly Taxa, NLAF Ecoregion.

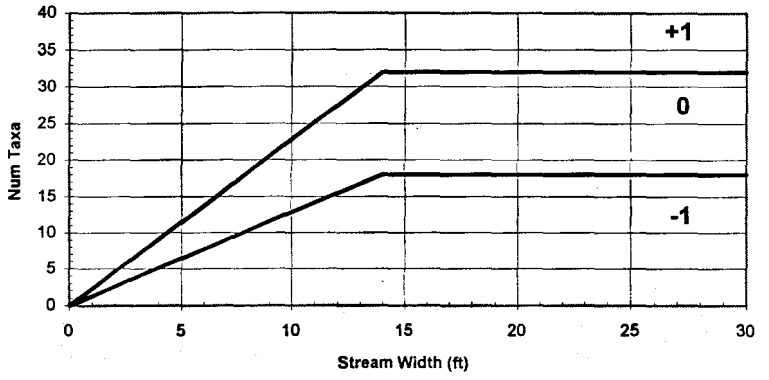

Figure 26: Scoring for Total Number of Macroinvertebrate Taxa, HELP Ecoregion.

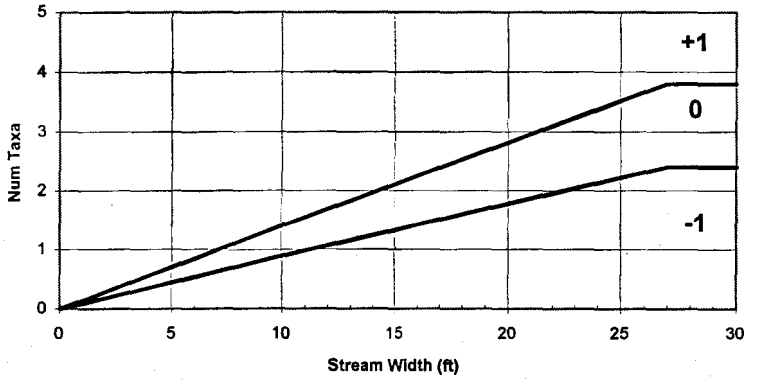

Figure 27: Scoring for Number of Mayfly Taxa, HELP Ecoregion.

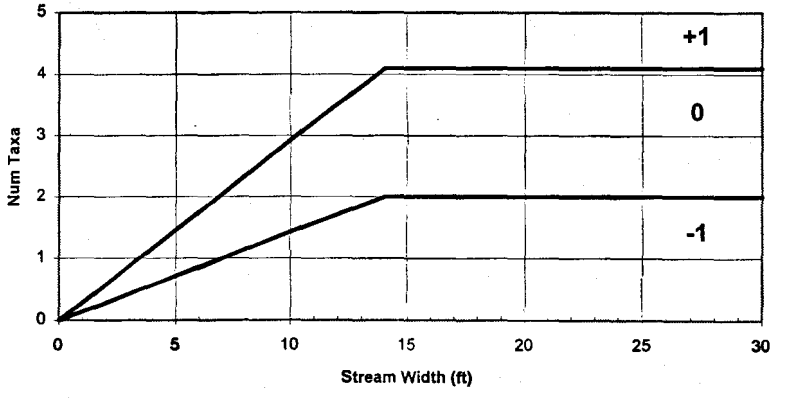

Figure 28: Scoring for Number of Caddisfly Taxa, HELP Ecoregion.

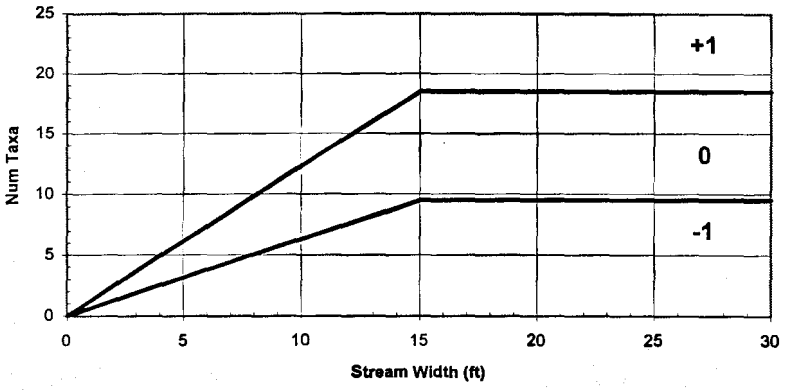

Figure 29: Scoring for Total Number of Macroinvertebrate Taxa, ECBP Ecoregion.

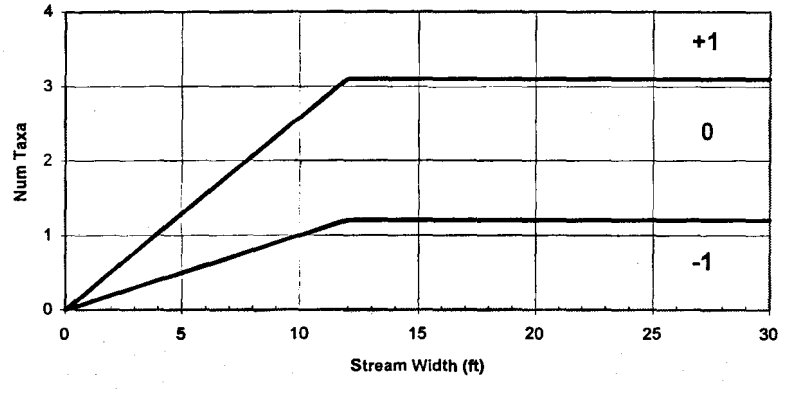

Figure 30: Scoring for Number of Mayfly Taxa, ECBP Ecoregion.

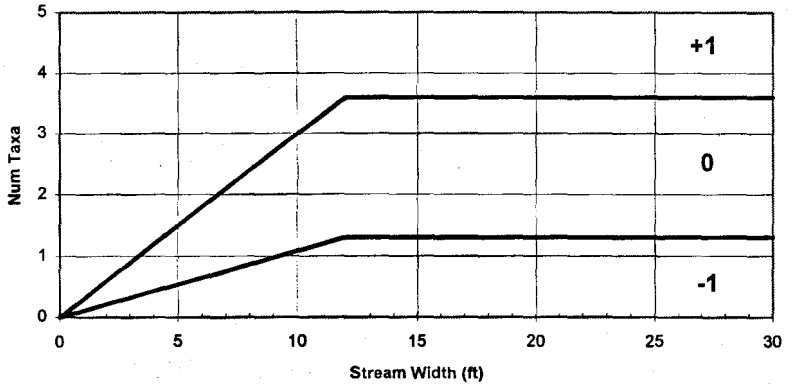

Figure 31: Scoring for Number of Caddisfly Taxa, ECBP Ecoregion.

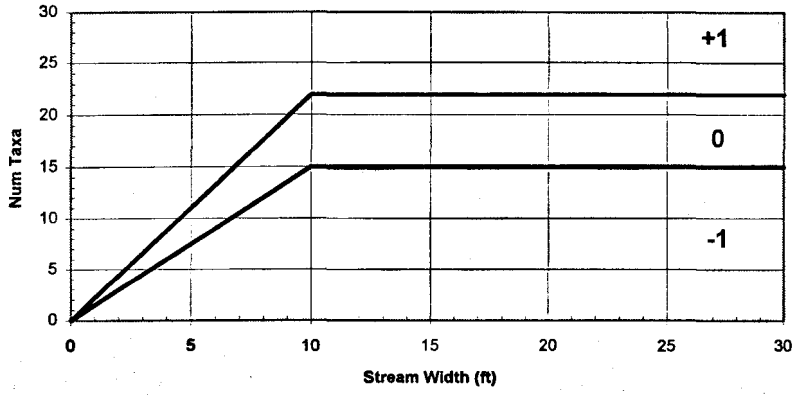

Figure 32: Scoring for Total Number of Macroinvertebrate Taxa, NCHF Ecoregion.

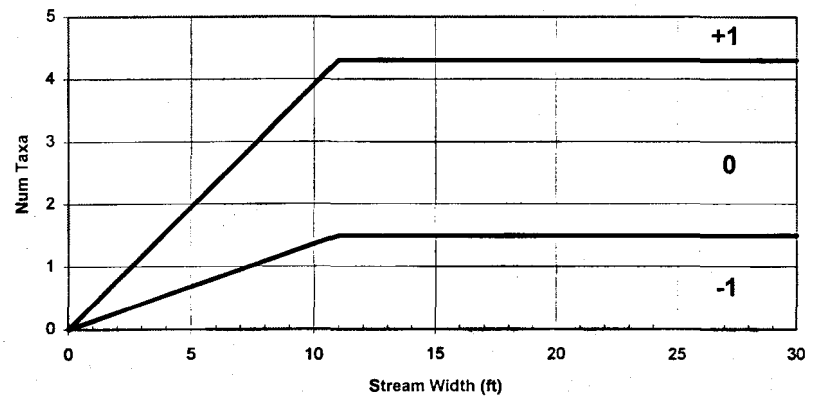

Figure 33: Scoring for Number of Mayfly Taxa, NCHF Ecoregion.

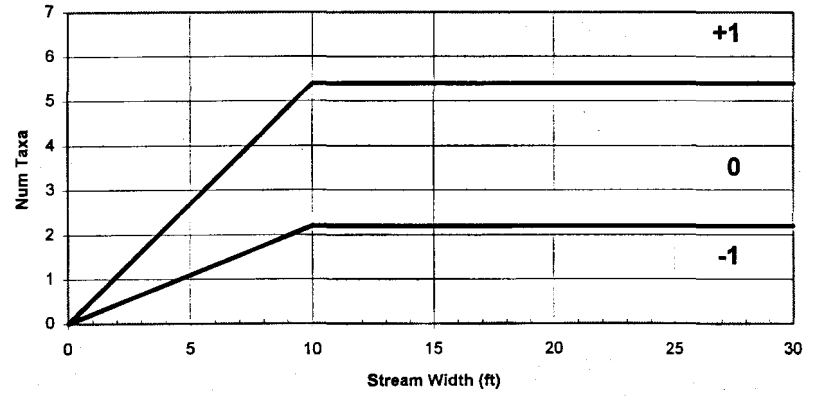

Figure 34: Scoring for Number of Caddisfly Taxa, NCHF Ecoregion.