

Technical Appendix A

Statistical Correlations

Statistical Correlations Pertaining to the WDOE Rating System as Used to Score Wetlands in Island County

by

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prepared for:

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May 2007

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Background

For assessing functions and values of a wetland, and ultimately for influencing the choice of suitable upland buffer width for the wetland, Washington Department of Ecology (WDOE) recommends use of a standardized assessment method:

Hruby, T. 2004. *Washington State Wetland Rating System for Western Washington, Revised*.
Washington Dept. of Ecology, Olympia.

That method requires a trained user to visit the wetland and visually assess characteristics (variables) that are believed to predict the wetland's performance in 3 categories: pollution-processing function and value (Water Quality), water-retaining function and value (Hydrologic), and wildlife support (Habitat). For the Habitat part of the method, the user assigns each of 9 variables (Table 1, first column) an ordinal score and then sums those into an overall Habitat Score. The scoring range is different for different variables, with some having a potential range of from 1 to 3, whereas others can range from 0 to 6; thus greater weight is implicit in some variables.

In summer 2005, a crew trained in the use of the WDOE method visited a statistical sample of 100 Island County wetlands and applied the WDOE Rating System (hereafter called the "original" method). After reviewing the collected data, in 2006 the ICPCD decided to propose future use of a modification of just the Habitat part of the method (hereafter called the "modified" method). The reasons for this were (a) the conditions in Island County of some WDOE method variables were found to be significantly different than those of much of western Washington (such as lack of major riverine wetlands) which the original method had been scaled to, and (b) input from many citizens urged the County to adopt a rating system that most landowners could apply, similar in concept to a checklist currently approved for use on agricultural lands, which would not require landowners to hire a private consultant or attend formal training in the method. Rather, for many buffer determinations, a landowner could use a streamlined and simplified modification of the original WDOE method. When using that modified version, a landowner would rely partly on countywide resource maps prepared in advance by the ICPCD and partly on his/her site-specific knowledge and observations. Wetland staff of the ICPCD would independently verify results of a cross-section of the assessments done by landowners.

The field data forms for both the original and modified versions of the Habitat part of the WDOE Rating System are shown in Appendix A and Appendix B, respectively. Table 1 compares the versions and summarizes the modifications. Table 2 shows the scores for the original and modified versions. An Excel spreadsheet containing the assessment data and scoring formulas as applied to the statistical sample of County wetlands, using both the original and modified methods, can be obtained from the ICPCD. The original method sums the scores of 9 habitat variables whereas the modified sums the scores of 7, but due to slightly different scoring ranges for the component variables the maximum point score possible differs only slightly for the two versions (36 for the original, 38 for the modified). When applied in Island County, the habitat scores were found to actually range 8 to 31 for the original version and 12 to 34 for the modified.

Objectives of This Analysis

Based on the in-field application of the WDOE Rating System to 85 randomly-selected non-estuarine wetlands in Island County by a WDOE-trained crew:

1. To determine which wetland characteristics used in the Habitat part of the WDOE System are most closely correlated.
2. To determine if total Habitat scores computed from a shortened version of the WDOE System modified for Island County correlate with the scores from the unmodified (original) WDOE System.

3. To determine if Habitat scores from both the unmodified and modified versions correlate with Total Score (the sum of the three functions).

Table 1. Variables used by the unmodified WDOE Wetland Rating System, and Island County’s modification of those.

Unmodified WDOE variable	Possible Score Range	Modified WDOE variable	Possible Score Range
H1_1 vegetation structures (# of types)	0-4	VEGETATION section #1 SAME AS ORIGINAL WDOE, but minor scale shift	1-4
H1_2 hydroperiods (# of types)	1-3	WATER section MODIFIED: water permanency & interspersions	0-6
H1_3 number of plant species	0-2	NOT INCLUDED	
H1_4 interspersions of habitats	0-3	NOT INCLUDED (merged into H1_2)	
H1_5 downed logs, snags, invasive plants, undercut banks, beaver den sites, submersed stems	0-6	VEGETATION section #3 downed logs (present/absent), snags (present/absent) SAME	0-2
		VEGETATION section #2 invasive plants – nearly the SAME	0-2
		VEGETATION section #3 = sum of 3a & b	0-4
H2_1 buffers	0-5	VEGETATION section #4 nearly the SAME	0-5
H2_2 distance to estuary (5 mi) or large wooded tract (>250 ac, >25 ac)	0-4	CONNECTIONS section #1a* extent of contiguous woodland (1, 10, or 100 ac) ignoring fragmentation by roads	0-3
		CONNECTIONS section #1b* extent of contiguous woodland considering fragmentation by roads	0-3
		CONNECTIONS section = sum of 1a & b*	0-6
		CONNECTIONS section #2a* distance to estuary or lake (300 ft or ½ mi), with surface connection	2-6
		CONNECTIONS section #2b* distance to wooded tract >250 ac or to pocket estuary, without surface water connection	1-5
		CONNECTIONS section #2* maximum of 2a or 2b	1-6
H2_3specFeat	0-4	NOT INCLUDED in <i>Habitat Worksheet</i>	
H2_4numwets “Wetland Landscape”	0-5	CONNECTIONS section #3* # of wetlands within 0.5 mi, with or without road separators	0-5
OrigDOE_Hscore = sum of all the above	1-36	ModDOE_Hscore = sum of bold items above	

* GIS-based

Methods

Scores from using the original and modified methods and their component variables were compared statistically using the Spearman rank-correlation test. That test makes minimal assumptions about distributional properties of the data and is well-suited for ordinal data such as scores. Statistical significance was defined as $p < 0.05$. Only 84 of the 100 visited wetlands were analyzed, partly because the habitat assessment component of the original method (as suggested in its instructions) was not applied to estuarine and other wetlands that had any of the “Significant Characteristics” listed by the method. For application of the modified method, the 3 landscape variables were measured using GIS applied to the 2001 NOAA land cover map which was based on satellite imagery.

Results

The Habitat Score generated by using the **original** WDOE method (OrigDOE_Hscore) correlated significantly with each of its 9 component variables. This was expected because the score is the sum of those variables. The variables with the weakest correlation to the Habitat Score were the number of wetlands nearby and their connecting vegetation (H2.4, Wetland Landscape), the wetland’s richness of plant species (H1.3), and the diversity of hydroperiods within the wetland (H1.2). Island County’s modified method dropped H1.3 and modified H1.2. All other variables contributing to the original WDOE Habitat Score were correlated very highly ($p < 0.0001$) with it.

The Habitat Score generated by using the **modified** WDOE method (ModDOE_Hscore) correlated significantly with 6 of its 7 component variables. This also was expected because the score is the sum of those variables. The only variable that was uncorrelated to the Habitat Score was H2.4new2, the number of wetlands within 0.5 mile, with and without road barriers, as computed using the GIS.

Island County’s modification of the hydroperiod variable (called H1.2new) correlated significantly with each of the 2 original variables that comprised it (H1.2 hydroperiod diversity and H1.4 interspersion). Similarly, the shortened modification of variable H1.5 correlated significantly with the unmodified longer version ($p < 0.0001$). The modification of the “Corridors and Connections” variable (H2.2newsum), which was derived using the County’s GIS layers, correlated significantly with the original version of this variable (H2.2) which was derived from field observation and review of aerial photographs. A variable, H2_2bWaterConnDNR, that describes wetland distance to estuary or lake (300 ft or ½ mi) and presence or lack of a surface connection also contributes to the Corridors and Connections calculation under the modified method, but was uncorrelated with H2.2. Finally, results of the County’s modification of the “Wetland Landscape” variable (H2.4new2) correlated significantly with those from the original WDOE version (H2.4). H2.4new relied entirely on GIS analysis of aerial imagery, whereas the H2.4 was based on in-field observations and manual review of aerial imagery.

Given the strong individual correlations described above, it is not surprising that the ultimate question:

Do the Habitat Scores using the **modified** method closely track those of the original method? would be answered affirmatively, and indeed the analysis showed this. The between-methods rank correlation of 0.74 is significant at $p < 0.0001$. Figure 1 is a plot of their relationship, and the predictive regression equation is:

$$Y = 7.18 + 0.79X$$

where Y is the Habitat Score from the modified WDOE method, and X is the Habitat Score from the original WDOE method. This equation (i.e., the landscape variables from the WDOE method, as we measured them using GIS) explains about 61% of the variation in the original WDOE Habitat Score.

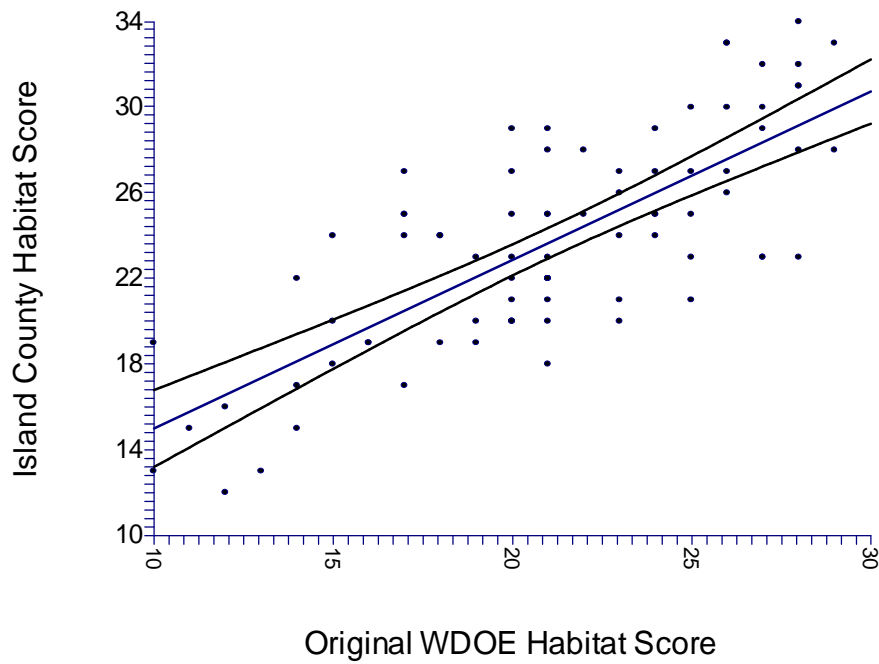


Figure 1. Correlation of Habitat Score from Island County (modified WDOE) method with Habitat Score for same wetlands using the original WDOE method

Table 2. Scores for individual wetlands assessed in Island County using the original and modified WDOE Rating System

Wetland 05 ID	HGM Class	WDOE Water Quality Function & Value	WDOE Hydrologic Function & Value	Habitat Function (WDOE)	Habitat Function (IC Modified Method)	Total Score (WDOE)	Total Score (using IC modified Habitat method)	DOE Category (based on WDOE score and WDOE's Special Characteristics)
1	L	20	12	31	30	63	62	2
1	L	24	4	28	30	56	58	2
6	D	16	12	29	28	57	56	2
19	S	12	2	10	17	24	31	4
47	D	14	10	15	21	39	45	3
48	D	14	10	24	24	48	48	3
55	S	14	5	26	28	45	47	3
62	D	12	16	20	21	48	49	3
71	D	10	12	30	30	52	52	2
88	D	26	14	24	26	64	66	1
90	D	4	5	12	10	21	19	4
102	S	14	5	21	18	40	37	3
108	D	6	14	18	26	38	46	3
121	D	12	14	16	19	42	45	3
132	D	14	10	23	22	47	46	3
136	D	8	12	20	21	40	41	3
138	D	28	12	20	18	60	58	2
144	D	10	10	8	13	28	33	4
151	D	28	12	21	27	61	67	2
154	D	16	12	18	26	46	54	3
171	D	16	10	15	15	41	41	3
173	D	4	7	17	14	28	25	4
174	S	6	5	14	16	25	27	4
198	S	18	2	17	23	37	43	3
202	D	32	10	21	26	63	68	2
203	D	14	12	26	26	52	52	1
205	S	14	5	20	23	39	42	3
206	D	8	10	10	11	28	29	4
223	D	16	12	28	32	56	60	2
231	D	14	10	12	14	36	38	3
240	D	28	14	25	28	67	70	2
248	D	14	8	12	21	34	43	3
255	D	18	8	26	33	52	59	1
275	S	7	8	17	24	40	39	3
283	S	14	10	24	23	48	47	3
285	S	24	14	15	14	53	52	3
291	S	14	24	27	33	63	71	2
294	S	13	10	24	25	47	48	3
310	D	14	8	23	23	45	45	3
324	D	22	7	19	20	48	49	3
335	D	8	12	28	32	48	52	3
336	S	5	3	20	18	28	26	4

Wetland 05 ID	HGM Class	WDOE Water Quality Function & Value	WDOE Hydrologic Function & Value	Habitat Function (WDOE)	Habitat Function (IC Modified Method)	Total Score (WDOE)	Total Score (using IC modified Habitat method)	DOE Category (based on WDOE score and WDOE's Special Characteristics)
337	D	1	3	11	17	15	21	4
344	D	18	10	21	29	49	57	3
350	D	9	12	27	27	48	48	3
354	D	7	8	20	28	35	43	3
356	D	22	8	20	22	50	52	3
369	D	10	8	11	11	29	29	4
374	S	16	10	21	20	47	46	3
378	D	12	14	26	33	52	59	2
382	S	20	16	23	23	59	59	2
383	S	9	8	21	21	38	38	3
385	D	24	12	19	22	55	58	1
402	D	20	12	21	24	53	56	2
409	D	4	12	17	22	33	38	3
418	D	24	9	25	26	55	59	2
423	D	8	7	27	28	42	43	3
425	D	16	8	21	20	45	44	3
440	D	16	10	28	24	54	50	2
454	D	14	20	19	20	51	54	3
469	D	10	12	16	19	38	41	3
473	D	9	8	28	28	45	45	3
476	D	5	10	26	30	41	45	3
477	S	3	8	25	22	36	33	3
479	S	22	10	25	20	57	52	2
481	D	4	8	16	18	28	30	4
494	D	12	4	21	18	37	34	3
509	D	28	8	23	27	59	63	2
511	S	6	5	27	20	38	31	3
525	D	6	8	13	10	27	24	4
624	D	32	12	21	22	65	66	2
655	D	6	5	18	18	29	29	4
662	D	8	10	25	20	43	38	3
1001	S	6	8	21	22	35	36	3
1055	S	16	8	21	25	45	49	3
1069	S	8	10	20	24	38	42	3
1070	S	8	8	20	26	36	42	3
1093	D	10	7	22	26	39	43	3
1138	S	3	5	23	20	31	28	3
1185	R	24	13	27	20	64	57	2
1186	S	9	8	22	22	39	39	3
1188	S	4	5	21	21	30	30	3
1205	R	24	22	24	23	70	69	1
1220.574	S	5	10	28	22	43	37	3

Prediction of Habitat Scores for All Island County Wetlands

The aforementioned analysis pertained only to the statistical sample of wetlands that were assessed in the field. What about all the other non-estuarine² wetlands in Island County? Is it possible, within some margin of confidence, to predict their approximate Habitat Score without actually visiting them? The answer is yes. A large number of variables were measured in all County wetlands (including the visited ones) using GIS. By correlating these variables with Habitat Score in just the visited wetlands and then extrapolating the results, a Habitat Score can be assigned to all wetlands. For doing this, only the GIS variables that were similar to landscape variables employed by the original WDOE method were used. They are:

variable A (H221ab, the extent of woodland contiguous to the wetland)

variable B (H222, the wetland distance to estuary or lake), and

variable C (H2_4new2, the number of wetlands within ½ mile)

The predictive regression equation for the Island County modified method is:

$$\text{Habitat Score} = 9.87 + 1.97*A + 1.27*B + 0.42*C$$

This accounted for about 62% of the score variation ($r^2 = 0.62$).

Based on this equation, the distribution of Habitat Scores using the Island County modification of the WDOE method as applied to all non-estuarine wetlands might be as follows:

>28 points = 53 wetlands (6%, vs. 4% if inferred only from visited sites)

20-28 points = 633 wetlands (69% vs. 65% if inferred only from visited sites)

<20 points = 235 wetlands (26% vs. 31% if inferred only from visited sites)

Thus, the visited wetlands tended to underestimate slightly the proportion of Island County wetlands that would fall into a higher (more restrictive) category based only on their Habitat Score.

Comparison With Scores for Water Quality and Hydrologic Functions

The correlation between the Total Score (sum of all 3 functions) and the Habitat score based on the unmodified WDOE method was 0.61. When the County's modified version was used, the correlation coefficient was slightly stronger: 0.67. **The correlation between the Total Score from the unmodified vs. modified versions was a remarkable 0.95.** All correlations mentioned in this paragraph were, statistically speaking, highly significant ($p < 0.001$).

² The WDOE method does not compute Habitat Score for estuarine wetlands because they qualify as Special Characteristic wetlands