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Stephen A. Bortone
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Stephen A. Bortone

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Doyal Van Orman

Biology Department
University of West Florida
Pensacola, Florida 32514

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INTRODUCTION

There is a critical need for accurate data in order to make decisions regarding the construction, emplacement, and further development of artificial reefs in the State of Florida. The past, present and potential importance of artificial reefs as a center for recreational and commercial fishing activities as well as a solution to problems in management and conservation of marine fisheries has a direct affect on Florida's economy. At a meeting of Florida Sea Grant's Reef Advisory Committee it was made clear through discussion with the committee members that Florida needs to be able to make intelligent and rational decisions concerning the emplacement of artificial reefs. A problem arises, however, in the fact that there are too few data available on which to base these decisions.

Through our continued discussions a point was made which might help solve some of the immediate problems in the decision-making and evaluation process as well as indicate the future needs regarding needed research on artificial reefs. This has to do with determining what data on artificial reef biology were available and then an evaluation of those data. A data matrix listing reefs on the vertical axis and the associated biotic and abiotic data or attributes available from published and non-published sources on the horizontal axis would permit several goals of our initial investigations into the future of artificial reef research to be realized: 1) a compilation of what data were available; 2) an indication of the completeness and extensiveness of the data; 3) a summary of the descriptive statistics of the data; 4) a preliminary analysis of the relationship among the biotic and abiotic parameters through correlation analysis; 5) some preliminary modeling of the artificial reefs to form the basis of prediction through stepwise and multiple linear regression analysis. This compilation, description and analysis would give those of use interested in understanding the present state-of-knowledge, the current status of available research, and questions which should be posed a perspective on the entire subject.

This study is to be used in concert with two other Florida Sea Grant College sponsored research projects: one dealing with an annotated bibliography of most of the available literature known to refer to artificial reefs; and another review paper summarizing the past research on artificial reefs as well as indicating trends and future needs in artificial reef research. The present study when coupled with the other two studies will give investigators interested in the development and future status of Florida's artificial reefs a distinct advantage in planning future research so that it will be efficient, significant, and useful to all those interested in this potentially valuable resource.

MATERIALS AND METHODS

A careful search was made to find sources of data for the matrix. Although there are literally thousands of articles written on artificial reefs, our prime concern was to find articles in which a field study had been conducted which addressed both biological and non-biological data. A second concern was to obtain data from studies relevant and applicable to Florida zoogeographic areas. Therefore, our main emphasis was on studies conducted in the Carolinian province, and in the subtropical and tropical Western Atlantic.

Studies from areas outside those mentioned above were considered if they were particularly complete and/or if they were from areas where at least comparisons might be made on the family or the generic level.

In total, data were obtained from 177 reefs primarily from Florida and the southeastern coastal areas of the United States. These reefs were listed on the vertical axis, and their associated physical and biological parameters were listed horizontally. The physical data were obtained directly from the research sources or, as in many cases because the data were incomplete or lacking, the data were supplemented from other sources. Below are presented the physical parameters considered in this report along with the code used in the computer printout found in the appendix, the criteria for inclusion, definition of units, and source of information.

Each reef was assigned a five digit identification number. The first two digits of the number indicate the state in which the reef is located. The third digit gives its geographic area (generally follows those areas from the Florida Artificial Reef Atlas), and the final two digits identify the specific site. For permitted reefs in Florida the areas and sites correspond to the numbers listed in the Atlas of Artificial Reefs published by Florida Sea Grant, Non-permitted Florida reefs and reefs located in other states can be identified from the literature references.

The state legend is as follows:

00 - Florida	01 - Maine
02 - New Hampshire	03 - Massachusetts
04 - Rhode Island	05 - Connecticut
06 - New York	07 - New Jersey
08 - Delaware	09 - Maryland
10 - Virginia	11 - North Carolina
12 - South Carolina	13 - Georgia
14 - Alabama	15 - Mississippi
16 - Louisiana	17 - Texas
18 - California	19 - Oregon
20 - Washington	21 - Hawaii
22 - Mexico	23 - Puerto Rico
24 - Virgin Islands	25 - All others

The following is a listing of reef identification numbers with references to the literature cited:

Reef Number	Literature
00348	Stone et al., 1979
00429	Smith et al., 1979
00634/00640	Hastings, 1979
00635	Bortone, 1976
00636	Wickham et al., 1973
00637/00638	Hastings et al., 1976
00639	Klima and Wickham, 1969
07011/07111/12011	Steimle and Ogren, 1982
12010	Parker et al., 1979
14001	Crozier et al., 1977

15001	Lukens, 1981
16001	Sonneir et al., 1976
18001/18002/18003	Turner et al., 1969
20008	Walton, 1982
20010	Hueckel and Slayton, 1982
23001	Fast, 1974
24001	Randall, 1963

Below are listed the headings on the computerized data matrix as printed in the appendix:

YR-BLT: Year built, usually determined from Florida Sea Grant's Atlas of Artificial Reefs (Aska and Pybas, 1983).

MATERIALS: Primary material of which the reef was composed:

A = Aluminum	P = Plastic or fiberglass
R = Rubber tires	F = Fish aggregating device
C = Cement	N = Natural materials (rocks)
S = Steel	W = Wood

PROFILE: H = High, L = Low, S = Special

The profile should be a ratio of height to water depth, but for our purposes structures such as boats, barges, ships, or other vessels were considered to have high profile. Rubber, tires, etc., were considered to have low profile. The category "special" indicates mid-water fish attractors such as those used by Klima and Wick ham (1971).

AREA: Recorded as M^2 when available.

DEPTH: Recorded in meters.

SUBSTRATE: Recorded as: S = sand; M = mud; G = gravel; C = coral; R = rocks; 1 = shell material; V = vegetation.

DST-SHORE: Nearest landfall in nautical miles.

DRAINAGE: Each major watershed for the Florida coastal area was assigned an identifying number:

1 = Nassua Sound	2 = St. Johns Rivers
3 = Iolomato River	4 = Mantanzas River
5 = Halifax River	6 = Banana River
7 = Indian River	8 = Lake Worth
9 = Biscayne Bay	10 = Florida Bay
11 = San Carlos Bay	12 = Charlotte Harbor
13 = Tampa Bay	14 = Waccasassa Bay
15 = Suwannee River	16 = Deadman Bay

17 = Apalachee Bay | 18 = Apalachicola Bay
19 = St. Andrews Bay | 20 = Choctawhatchee Bay
21 = Pensacola Bay | 22 = Perdido Bay
23 = Mobile Bay | 24 = Mississippi Sound
25 = Big Marco River

A drainage code was then assigned to each reef based on its proximity to that drainage.

DST-PASS: Distance in nautical miles to the pass or entrance of the closest drainage.

DRAIN-VOL: Mean volume of discharge of the nearest drainage in cubic feet per second. Sources for the drainage information was State Univ. System of Florida Institute of Oceanography (1973), U.S. Dept. of Interior (1975), and U.S. Dept. of Comm. (1980).

DST-100F Distance in nautical miles to the 100 fathom depth. Plotted and measured from NOAA charts 1:80000 and 1:486200.

WIND-DIR: Predominant wind direction. The direction in degrees from which the wind most often blows. Obtained from Bureau of Land Management charts, Outer Continental Shelf, Eastern Gulf of Mexico, Visual No. 6.

WIND-VEL: Mean wind velocity recorded in nautical miles per hours (knots). Obtained from Bureau of Land Management charts, Outer Continental Shelf, Eastern Gulf of Mexico, Visual No. 6.

LATITUDE: Latitude of the site recorded as xx degrees xx minutes xx seconds.

CURR-DIR: Resultant water current entered in degrees. Recorded as the direction the current sets and obtained from Bureau of Land Management charts, Outer Continental Shelf, Eastern Gulf of Mexico, Visual No. 6.

TIDE-TYPE: S = semidiurnal; D = diurnal; M = mixed. Obtained from Fernald (1981).

TIDAL-VA: Tidal variation. No data were obtained for this category.

W-STMP-L: Lowest winter surface temperature. Entered in Farenheit.

W-STMP-H: Highest winter surface temperature.

W-STMP-A: Average winter surface temperature.

S-STMP-L:	Lowest summer surface temperature.
S-STMP-H:	Highest summer surface temperature.
S-STMP-A:	Average summer surface temperature.
W-BTMP-L:	Lowest winter bottom temperature.
W-BTMP-H:	Highest winter bottom temperature.
W-BTMP-A:	Average winter bottom temperature.
S-BTMP-L:	Lowest summer bottom temperature.
LONGITUD:	Longitude entered as xx degrees xx minutes xx seconds.
S-BTMP-H:	Highest summer bottom temperature.
S-STMP-A:	Average summer bottom temperature.
W-SSAL-L:	Lowest winter surface salinity recorded as part per thousand.
W-SSAL-H:	Highest winter surface salinity.
W-SSAL-A:	Average winter surface salinity.
S-SSAL-L:	Lowest summer surface salinity.
S-SSAL-H:	Highest summer surface salinity.
S-SSAL-A:	Average summer surface salinity.
W-BSAL-L:	Lowest winter bottom salinity.
W-BSAL-H:	Highest winter bottom salinity.
W-BSAL-A:	Average winter bottom salinity.
S-BSAL-L:	Lowest summer bottom salinity.
S-BSAL-H:	Highest summer bottom salinity.
S-BSAL-A:	Average summer bottom salinity.
WINTER:	Total number of individuals within each family by reef for Dec., Jan., and Feb.
SUMMER:	Total number of individuals within each family by reef for June., Jul., and Aug.
WIN-SUM:	The combined sums of the above.

LWIN:	Logarithm scale of winter abundance.
LSUM:	Logarithm scale of summer abundance.
LWIN-LSUM:	Logarithm scale of combined winter and summer abundance.

Species identified in the literature were arranged according to the Hoese, Moore, and Sonneir (1977) classification scheme. Those species not included in their publication were entered at the end of appropriate families. In cases where information was incomplete only the family identification code was used. These data were recorded for each reef with he reported abundance entered for each species in the appropriate season in which the data were collected. This provided abundance figures by seasons for each species by reef. If seasonal information was lacking, the abundance was entered as annual data. In instances where abundance was reported in qualitative terms numerical values were substituted for comparative analysis purposes. The numeric values uses were: rare = 1; moderate or occasional = 10; common or frequent = 100; and abundant = 1000.

For analysis the biological data set was reduced to four families which are represented by the following codes: 54 = Serranids; 62 = Carangids; 65 = Lutjanids; and 68 = Haemulids. These families represent the majority of reef target species sought by recreational fishermen, and most often addressed in terms of reef fisheries management. The summer and winter seasons were selected for analysis because the greatest amount of biological abundance data was recorded for those seasons by the majority of the most thorough studies.

RESULTS

Physical parameters were obtained on 177 artificial reefs. Of these, 155 were permitted Florida reefs, and the remainder from other states, Puerto Rico, and the Virgin Islands. The composition of these structures was predominantly steel, a combination of steel, rubber, and concrete (mixed), or concrete (Fig. 1). Their physical attributes indicate a broad variance in most features (Table 1). It is noted that the reef areas, considered one of the most important factors by Smith (1972) and Walton (1982), was only addressed by seven of the studies. Other prominent factors such as the height of the structures, their cryptic nature, and accurate evaluations of the compositions of the substrate upon which they were placed were so few and varied that they had to be estimated and recorded in qualitative terms. As such they could not be used as part of the descriptive statistics of physical features or in the data matrix for analysis.

Of the 177 artificial structures for which physical data were available, only 23 provided biological information which paralleled our needs. Out of these 23 reefs, only nine were noted in Florida coastal waters, and only one study addressed a (1) Florida permitted reef (Smith et. al., 1979). Four of the other studies were conducted within the Carolinian province, and two in the tropical Western Atlantic. The remaining eight studies encompassed other coastal areas of the United States.

Reduction of the biotic data to four key families with abundance figures for winter and/or summer periods resulted in lowering the number of studies containing usable information to 11 reefs (Crozier et. al., 1977; Fast, 1974; Hastings, 1979; Hastings et. al., 1976; Klima and Wickham, 1969; Randall, 1963; Steimle and Ogren, 1982; Stone et. al., 1979; Wickham et. al., 1973). To complicate matters, two studies (on three separate reefs) presented abundance data in qualified terms such as rare, common, etc., and necessitated the conversion of the figures to a log scale for purposes of analysis (Crozier et. al., 1977; Hastings et. al., 1976). One study covering three reefs recorded only five species for each reef (Steimle and Ogren, 1982). The overall effect was that out of the reduced data, a combination of six to nine studies (depending on whether or not they contained data for all families for both seasons) were used for analysis (Table 2).

Correlation coefficient analysis was used to indicate relationships between biotic and abiotic variables associated with the reefs (Appendix). Correlations which were noted as significant (.05 level) are presented by family.

SERRANIDS

Winter abundance was negatively correlated with: river drainage volume, winter surface salinity, and summer surface salinity. Summer abundance was negatively correlated with winter surface salinity.

CARANGIDS

Winter abundance was negatively correlated with drainage volume, current velocity, winter surface salinity, and summer surface salinity. Winter abundance was positively correlated with distance from 100 fathoms.

LUTJANIDS

Both winter and summer abundance were positively correlated with depth and distance from shore.

HAEMULIDS

Winter abundance was negatively correlated with drainage volume and current velocity. Both winter and summer abundance was positively correlated with year built and winter surface temperature.

In most instances, family abundance was correlated to non-controllable factors such as drainage volume, temperature, salinity, and current velocity. The Lutjanids were the only family for which there were correlations (depth and distance to shore) that could be controlled by persons constructing artificial reefs.

Stepwise regression and attempts to build a predictive model using multiple linear regression were unsuccessful because of the number of missing data in the cells of the matrix.

DISCUSSION

There is no shortage of literature which addresses artificial reefs, and while many of the studies were designed to accomplish certain goals in artificial reef research most were not directed to support the type of information needed in this investigation. Within the available publications there exists a definite lack of continuity in the way researchers assess standing crops and present the results of their investigations.

Different methods of measuring the density and diversity of artificial reef communities include timed and non-timed spot counts, transect evaluations, kill and collect results, and hook and line assessments. Variations in the time frames in which the studies were conducted covered single and short term limited observations, seasonal studies with several assessments, and controlled samplings at regular intervals over extended periods.

The contrast in formats used in reporting the results of the studies was also significant. Some studies reported only on the target species on a reef while others recorded all species observed, but failed to provide abundance data or presented the information in qualitative terms. Other methods included reporting seasonal abundance as it was collected and recorded, or consolidating the results of extended efforts into one figure which ignored the impact of seasonal fauna changes. Few thoroughly addressed the influence of physical features to biological observations. This resulted in many missing cells in the data matrix and prevented analysis using stepwise and multiple linear regression.

These are examples of the variations in methodology which serve to adversely influence results of data combined from a wide range of sources. Considered in concert with the results of the data reduction and statistical analysis, it appears that the variations in sampling techniques and reporting methods would cause non-representative results.

CONCLUSIONS

Wide variations in the methodology in existing literature make it impossible to construct a data matrix and mathematical model which will be useful in predicting fish populations on artificial reefs. A consistent point which appeared as a result of our efforts is that a common or convertible method of collecting and reporting data is necessary if we expect to rely upon each other's research result for information useful in interpreting conditions and making decisions concerning management and research.

While this investigation failed to establish a functional data base, it provided other significant information. It helped provide valuable insight into our present status in evaluating artificial structures, the wide range of efforts being expended on artificial reef research by the scientific community, and a direction in which to proceed to attain our future research goals. It exemplified the need to construct a data matrix for use as a tool in directing further functional research, and established the necessary methodology with which it can be initiated. Then, as more and better data are produced, it will be possible to construct a predictive mathematical model.

Most of all, the results clearly show that a concerted, unified effort is needed if research is to proceed in a positive direction which will lead to the proper answers for successful management of our marine resources.

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FIGURE I. FREQUENCY DISTRIBUTION OF ARTIFICIAL REEFS BY TYPE OF MATERIAL

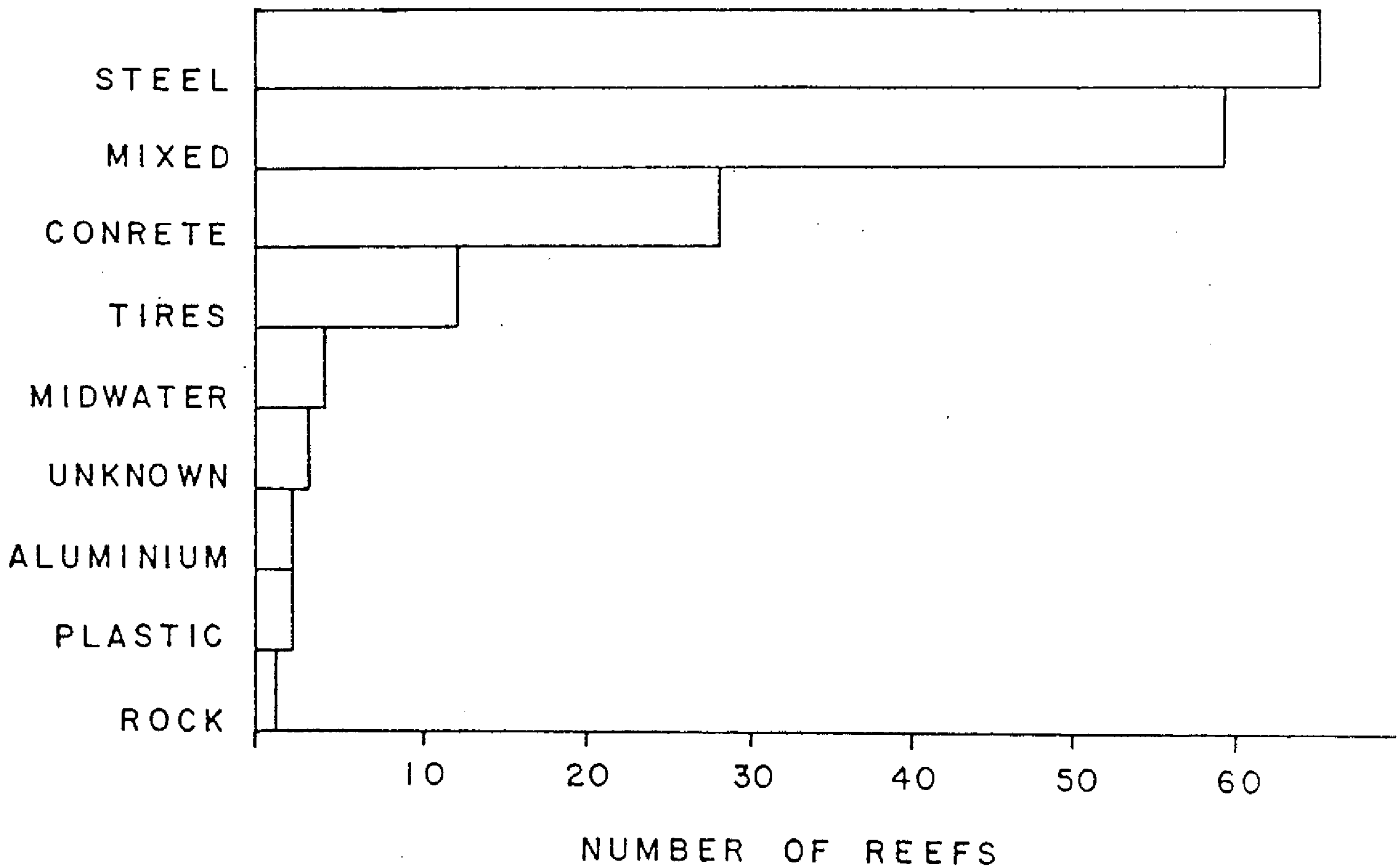

TABLE 1. DESCRIPTIVE STATISTICS OF THE PHYSICAL FEATURES FOR 177 ARTIFICIAL REEFS

VARIABLE	N	X	SD	MIN	MAX
Year Built	148	1974	8	1920	1982
Reef Areas (M^2)	7	209	157	40	450
Depth (M)	174	25	20	2	115
Distance to Shore*	169	7	6	0	29
Distance to Pass*	154	9	7	0	31
Nearest Drainage Vol. (M^3/SEC)	95	232	211	6	892
Distance to 100 Fath*	161	46	38	.3	127
Wind Velocity**	164	12	1	11	14
Current Velocity**	147	1	1	.1	3
Winter Surface Temp (C^o)	163	20	3	14	23
Summer Surface Temp (C^o)	163	28	1	28	29
Winter Bottom Temp (C^o)	25	23	2	15	23
Summer Bottom Temp (C^o)	25	25	1	24	29
Winter Surface Salinity (^{o}/oo)	162	30	11	5	36
Summer Surface Salinity (^{o}/oo)	162	31	10	5	36
Winter Bottom Salinity (^{o}/oo)	25	6	6	5	35
Summer Bottom Salinity (^{o}/oo)	25	35	1	35	36

*Nautical Miles
**Knots

TABLE 2. DESCRIPTIVE STATISTICS FOR THE NUMBER OF INDIVIDUALS OF FOUR MAJOR FAMILIES OF FISHES OCCURRING ON ARTIFICIAL REEFS DURING THE SUMMER AND (IN PARENTHESES) WINTER SEASONS

FAMILY	NO. OF STUDIES	NO. OF INDIVIDUALS	SD	MIN	MAX
Serranidae					
Groupers/Seabasses	9	369	580	2	1502
	(6)	(343)	(582)	(1)	(1501)
Carangidae					
Jacks	8	1340	1434	15	4000
	(6)	(1012)	(1096	(0)	(2022)
Lutjanidae					
Snappers	7	613	983	0	2101
	(6)	(359)	(804)	(0)	(2000)
Haemulidae					
Grunts	7	1257	750	50	2010
	(6)	(774)	(759)	(6)	(2000)

APPENDIX

Physical and Biological Data

and

Correlation Coefficient Analysis

SUMS FOR BIO/DATA FOR CERTAIN FAMILIES 10:03 THURSDAY, DECEMBER 15, 1983 1

OBS	REEF	FAMILY	WINTER	SUMMER	WIN_SUM	LWIN	LSUM	LWIN_SUM
1	00348	54	11	23	34	2.7081	6.2916	8.8774
2	00348	62	15	15	30	2.6391	3.2581	4.3944
3	00348	65	4	25	29	0.6931	5.1358	5.2470
4	00348	68	494	1201	1695	14.0886	19.8577	24.5501
5	00634	54	7	9	16	2.4849	2.6391	4.4998
6	00634	62	0	65	65	.	8.5603	8.5603
7	00634	65	0	0	0	.		.
8	00634	68	6	50	56	1.7918	3.9120	4.0254
9	00636	62		300	.	.	13.8155	.
10	00637	54	311	400	711	16.1181	18.4207	20.5954
11	00637	62	2012	1510	3522	16.1181	32.2362	36.0303
12	00637	65	111	2001	2112	6.9078	13.8155	14.6139
13	00637	68	1010	1000	2010	9.2103	6.9078	9.9035
14	00638	54	232	1222	1454	16.1181	20.7233	23.4865
15	00638	62	2022	2420	4442	18.4207	36.8414	40.8172
16	00638	65	30	121	151	6.9078	9.2103	10.4919
17	00638	68	1101	2010	3111	11.5129	16.1181	17.8819
18	00639	62		4000	.	.	27.6310	
19	07011	54		7	.	.	1.9459	.
20	12011	54		60	.	.	6.8307	
21	14001	54	1501	1502	3003	29.9336	29.9336	34.7854
22	14001	62	2000	2111	4111	13.8155	20.7233	22.1096
23	14001	65	2000	2101	4101	13.8155	18.4207	19.8870
24	14001	68	2000	2000	4000	13.8155	13.8155	15.2018
25	23001	54	1	2	3	0.0000	0.0000	0.6931
26	23001	62	15	300	315	2.7081	5.7038	5.7526
27	23001	65	11	21	32	2.3026	5.1933	6.8449
28	23001	68	34	663	697	6.3135	14.4970	15.1421
29	24001	54		99	.	.	11.9016	
30	24001	65		25			3.2189	
31	24001	68		1872			16.7981	

OBS	REEF	YR_BLT	MATERIAL	PROFILE	AREA	DEPTH	SUBSTRAT	DST_SHRE	DRAINGES	DST_PASS	DRAIN_VO	DST_IOF	WIND_DIR	WIND_VEL	LATITUDE	CURR_DIR	CURR_VEL	TIDE_TYP	TIDAL_VA	V_STMP_L	V_STMP_H	V_STMP_A	S_STMP_L	S_STMP_H
1	00348	72	R	L		14	RCSG	4.00	9	4.7		4.9	90	11.7	252235			M		61	78	74	80	89
2	00348	72	R	L		14	RCSG	4.00	9	4.7		4.9	90	11.7	252235			M		61	78	74	80	89
3	00348	72	R	L		14	RCSG	4.00	9	4.7		4.9	90	11.7	252235			M		61	78	74	80	89
4	00348	72	R	L		14	RCSG	4.00	9	4.7		4.9	90	11.7	252235			M		61	78	74	80	89
5	00634	68	N	H		13	S	0.00	0	0.0	8352	43.0	90	11.0	302300	330	0.3	D		49	59	57	80	89
6	00634	68	N	H	.	13	S	0.00	0	0.0	8352	43.0	90	11.0	302300	330	0.3	D	.	49	59	57	80	89
7	00634	68	N	H		13	S	0.00	0	0.0	8352	43.0	90	11.0	302300	330	0.3	D	.	49	59	57	80	89
8	00634	68	N	H	.	13	S	0.00	0	0.0	8352	43.0	90	11.0	302300	330	0.3	D	.	49	59	57	80	89
9	00636	71	P	S	.	5		.	9		6367		90	11.0	.	315	0.2	D	.	62	74	64	80	86
10	00637		S	H	40	32	S	11.00	9	11.2	6367	40.0	90	11.0	300030	315	0.2	D		62	74	64	80	86
11	00637		S	H	40	32	S	11.00	9	11.2	6367	40.0	90	11.0	300030	315	0.2	D	.	62	74	64	80	86
12	00637		S	H	40	32	S	11.00	9	11.2	6367	40.0	90	11.0	300030	315	0.2	D	.	62	74	64	80	86
13	00637		S	H	40	32	S	11.00	9	11.2	6367	40.0	90	11.0	300030	315	0.2	D	.	62	74	64	80	86
14	00638		S	H	345	18	S	1.60	9	2.2	6367	50.0	90	11.0	300712	315	0.2	D	.	62	74	64	80	86
15	00638		S	H	345	18	S	1.60	9	2.2	6367	50.0	90	11.0	300712	315	0.2	D	.	62	74	64	80	86
16	00638		S	H	345	18	S	1.60	9	2.2	6367	50.0	90	11.0	300712	315	0.2	D	.	62	74	64	80	86
17	00638		S	H	345	18	S	1.60	9	2.2	6367	50.0	90	11.0	300712	315	0.2	D	.	62	74	64	80	86
18	00639	69	FW	S				.	9		6367		90	11.0		315	0.2	D		62	74	64	80	86
19	07011	66	SR	L		18	SIR	1.80																
20	12011	67	S	L		15	S	7.00																

OBS	S_STMP_A	V_BTMP_L	V_BTMP_H	V_BTMP_A	S_BTMP_L	LONGITUD	S_BTMP_H	S_BTMP_A	V_SSAL_L	V_SSAL_H	V_SSAL_A	S_SSAL_L	S_SSAL_H	S_SSAL_A	V_BSAL_L	V_BSAL_H	V_BSAL_A	S_BSAL_L	S_BSAL_H	S_BSAL_A	FAMILY	WINTER	SUMMER	WIN_SUM	LWIN	LSUM	LWIN_SUM
1	84					330840					36			35							54	11	23	34	2.7081	6.2956	8.8774
2	84					800840					36			35							62	15	15	30	2.6391	3.2581	4.3944
3	84					300840					36			35							65	4	25	29	0.6931	5.1358	5.2470
4	84					800840					36			35							68	499	1201	1695	14.0086	19.8577	24.5501
5	84					843024															54	7	9	16	2.4849	3.6391	4.4998
6	84					843024															62	0	65	65		8.5403	8.5403
7	84					843024															65	0	0	0			
8	84					843024															68	4	50	56	1.7918	3.9120	4.0254
9	84										34			34							62		300			13.6155	
10	84					855412					34			34							54	311	400	711	16.1161	18.4207	20.5951
11	84					855412					34			34							62	2012	1510	3522	16.1181	32.2362	36.0303
12	84					855412					34			34							65	111	2001	2112	6.9078	13.8155	11.6139
13	84					855412					34			34							68	1010	1000	2010	9.2103	6.9078	9.9035
14	84					854624					34			34							54	232	1222	1454	16.1181	20.7233	23.4865
15	84					854624					34			34							62	2022	2420	4442	18.4207	36.8414	40.8172
16	84					854624					34			34							65	30	121	151	6.9078	9.2103	10.6919
17	84					854624					34			34							68	1101	2010	3111	11.5129	16.1181	17.0019
18	84										34			34							62		4000			27.6310	
19																					54		7			1.9459	
20																					56		60			[illegible]	

OBS	RECT	TI_SLT	MATERIAL	PROFILE	AREA	DEPTH	SUBSTRAT	DST_SHRE	DRAINAGE	DST_PASS	DRAIN_VO	DST_100F	WIND_DIR	WIND_VEL	LATITUDE	CURR_DIR	CURR_VEL	TIDE_TYP	TIDAL_VA	W_STMP_L	W_STMP_H	W_STMP_A	S_STMP_L	S_STMP_H	S_STMP_A	W_BTMP_L	W_BTMP_H	W_BTMP_A	S_BTMP_L
21	14001	74	S	H			S																						
22	14001	74	S	H			S																						
23	14001	74	S	H			S																						
24	14001	74	S	H			S																						
25	23001	71	R	L	165	20	S	3.50							175550														
26	23001	71	R	L	165	20	S	3.50							175550														
27	23001	71	R	L	165	20	S	3.50							175550														
28	23001	71	R	L	165	20	S	3.50							175550														
29	24001	60	C	L	50	9	G	0.06																					
30	24001	60	C	L	50	9	G	0.06																					
31	24001	60	C	L	50	9	G	0.06																					

OBS	LONGITUD	S_BTMP_H	S_BTMP_A	W_SSAL_L	W_SSAL_H	W_SSAL_A	S_SSAL_L	S_SSAL_H	S_SSAL_A	W_BSAL_L	W_BSAL_H	W_BSAL_A	S_BSAL_L	S_BSAL_H	S_BSAL_A	FAMILY	WINTER	SUMMER	WIN_SUM	LWIN	LSUM	LWIN_SUM
21																54	1501	1502	3003	29.9336	29.9334	34.7856
22																62	2000	2111	4111	13.8155	20.7233	22.1094
23																65	2000	2101	4101	13.8155	16.4207	19.8070
24																68	2000	2000	4000	13.8155	13.8155	15.2018
25	670315															54	1	2	3	0.0000	0.0000	0.6931
26	670315															62	15	300	315	2.7081	5.7038	5.7526
27	670315															65	11	21	32	2.3026	5.1930	4.8469
28	670315															68	34	563	597	5.3135	14.4970	15.1431
29																54		99			11.9810	
30																65		25			3.2189	
31																68		1872			16.7981	

FAMILY=54

VARIABLE	N	MEAN	STD DEV	SUM	MINIMUM	MAXIMUM
IR_BLT	-	68.57142857	5.09434794	480.00000000	60	74
AREA	4	155.00000000	151.05184747	620.00000000	48	365
DEPTH	8	17.37500000	6.54393327	139.00000000	9	32
DST_SHRE	8	3.62000000	3.74444495	28.96000000	0	11
DST_PASS	4	4.52500000	4.84456236	18.10000000	0	11
DRAIN_VO	3	7028.66666667	1146.94028434	21086.00000000	6367	8352
DST_100F	4	34.47500000	20.15694667	137.90000000	5	50
WIND_VEL	4	11.17500000	0.35000000	44.70000000	11	11
CURR_VEL	3	0.23333333	0.05773503	0.70000000	0	0
V_STMP_A	4	64.75000000	6.99504587	259.00000000	57	74
S_STMP_A	4	84.00000000	0	336.00000000	84	84
V_SSAL_A	3	34.66666667	1.15470054	104.00000000	34	36
S_SSAL_A	3	34.33333333	0.57735027	103.00000000	34	35
WINTER	6	343.83333333	582.13208696	2063.00000000	1	1501
IWIN	4	11.22712573	11.60031534	47.36275436	0	30
SUMMER	9	369.33333333	580.48341923	3324.00000000	2	1502
WIN_SUM	6	870.16666667	1191.29564719	5221.00000000	3	3003
ISUM	7	10.97620173	10.17662222	77.88581560	0	38
IWIN_SUM	6	15.52298044	12.03089065	93.13788266	1	35

FAMILY=54

CORRELATION COEFFICIENTS / PROB > |R| UNDER H0:RHO=0 / NUMBER OF OBSERVATIONS

	TR_SLT	AREA	DEPTH	DST_SHRE	DST_PASS	DRAIN_VO	DST_100F	WIND_VEL	CURR_VEL	V_STMP_A	S_STMP_A	V_BTMP_A	S_BTMP_A
WINTER	0.85784	-0.11502	0.77577	0.63388	0.66878	-0.96814	0.53941	-0.55407	-0.96814	-0.11065	0.00000		
	0.1421	0.9266	0.1233	0.2508	0.3312	0.1611	0.4606	0.4439	0.1611	0.8894	1.0000		
	4	3	5	5	4	3	4	4	3	4	4	0	0
SUMMER	0.60439	0.79757	0.27313	0.02665	-0.02514	-0.74788	0.59847	-0.45784	-0.74788	-0.08998	0.00000		
	0.1506	0.2024	0.5118	0.9501	0.9749	0.4631	0.4015	0.5422	0.4631	0.9100	1.0000		
	7	4	8	8	4	3	4	4	3	4	4	0	0
WIN_SUM	0.85895	0.62897	0.34123	0.12776	0.13103	-0.85623	0.62172	-0.50822	-0.85623	-0.10019	0.00000		
	0.1411	0.5735	0.5741	0.8378	0.8690	0.3454	0.3783	0.4918	0.3454	0.8998	1.0000		
	4	3	5	5	4	3	4	4	3	4	4	0	0
LWIN	0.84515	0.13207	0.62031	0.47351	0.52278	-1.00000	0.59388	-0.56778	-1.00000	-0.11224	0.00000		
	0.1549	0.9157	0.2643	0.4205	0.4772	0.0001	0.4061	0.4322	0.0001	0.8878	1.0000		
	4	3	5	5	4	3	4	4	3	4	4	0	0
LSUM	0.40164	0.23367	0.36867	0.30878	0.49418	-0.99314	0.48307	-0.42908	-0.99314	0.04492	0.00000		
	0.3718	0.7663	0.3688	0.4691	0.5058	0.0744	0.5169	0.5709	0.0746	0.9551	1.0000		
	7	4	8	8	4	3	4	4	3	4	4	0	0
LWIN_SUM	0.86426	0.25382	0.49102	0.40046	0.47616	-0.98868	0.46327	-0.40188	-0.98868	0.07280	0.00000		
	0.1317	0.8366	0.4009	0.5041	0.5238	0.0959	0.5367	0.5981	0.0959	0.9272	1.0000		
	4	3	5	5	4	3	4	4	3	4	4	0	0

	V_SSAL_A	S_SSAL_A	V_BSAL_A	S_BSAL_A	WINTER	LWIN
WINTER	-0.94720	-0.94720			1.00000	0.90534
	0.1635	0.1635			0.0000	0.0130
	3	3	0	0	6	6
SUMMER	-0.74204	-0.74204			0.80802	0.91884
	0.4677	0.4677			0.0517	0.0096
	3	3	0	0	6	6
WIN_SUM	-0.85230	-0.85230			0.94343	0.95955
	0.3504	0.3504			0.0047	0.0024
	3	3	0	0	6	6
LWIN	-1.00000	-1.00000			0.90534	1.00000
	0.0001	0.0001			0.0130	0.0000
	3	3	0	0	6	6
LSUM	-0.98891	-0.98891			0.83602	0.98520
	0.0949	0.0949			0.0381	0.0003
	3	3	0	0	6	6
LWIN_SUM	-0.98024	-0.98024			0.84948	0.98511
	0.1268	0.1268			0.0323	0.0003
	3	3	0	0	6	6

FAMILY=62

VARIABLE	N	MEAN	STD DEV	SUM	MINIMUM	MAXIMUM
YR_BLT	6	71.16666667	2.78687100	427.00000000	68	74
AREA	3	190.00000000	163.93596311	570.00000000	40	365
DEPTH	6	17.00000000	8.98868202	102.00000000	5	31
DST_SHRE	5	4.02000000	4.21331224	20.10000000	0	11
DST_PASS	4	4.52500000	4.91656236	18.10000000	0	11
DRAIN_VO	5	6764.00000000	887.71818707	33820.00000000	6347	8352
DST_100F	4	34.47500000	10.15694669	137.90000000	5	50
WIND_VEL	6	11.11666667	0.28577380	66.70000000	11	12
CURR_VEL	5	0.22000000	0.01471136	1.10000000	0	0
V_STMP_A	6	64.50000000	5.43139025	387.00000000	57	74
S_STMP_A	6	84.00000000	0	504.00000000	84	84
V_SSAL_A	5	34.40000000	0.89442719	172.00000000	34	36
S_SSAL_A	5	34.20000000	0.44721360	171.00000000	34	35
WINTER	6	1010.66666667	1096.21123269	6064.00000000	0	2022
LWIN	5	10.74027890	7.56176743	53.70139448	3	18
SUMMER	8	1340.12500000	1434.74184559	10721.00000000	15	4000
WIN_SUM	6	2080.83333333	2152.26925980	12485.00000000	30	4442
LSUM	8	18.59618525	12.70611198	148.76948199	3	37
LWIN_SUM	6	19.61072282	15.94526897	117.66433692	4	41

CORRELATION COEFFICIENTS / PROB > |R| UNDER H0:RHO=0 / NUMBER OF OBSERVATIONS

	TR_BLT	AREA	DEPTH	DST_SHRE	DST_PASS	DRAIN_VO	DST_100F	WIND_VEL	CURR_VEL	V_STMP_A	S_STMP_A	V_BTMP_A	S_BTMP_A
WINTER	0.84106	0.13635	0.67150	0.49347	0.31741	-0.99999	0.59956	-0.57303	-0.99999	-0.11858	0.00000		
	0.1389	0.9129	0.2145	0.3981	0.4814	0.0027	0.4004	0.4278	0.0027	0.8814	1.0000		
	4	3	5	5	4	3	4	4	3	4	4	0	0
SUMMER	0.05543	0.54344	0.50267	0.23822	0.24419	-0.55079	0.64938	-0.41077	-0.55079	-0.10296	0.00000		
	0.9167	0.6342	0.3101	0.6994	0.7558	0.3360	0.3504	0.4041	0.3360	0.8461	1.0000		
	6	3	6	5	4	5	4	6	5	6	6	0	0
WIN_SUM	0.94126	0.33952	0.58200	0.37282	0.38512	-0.97993	0.63267	-0.57467	-0.97993	-0.12832	0.00000		
	0.1387	0.7795	0.3031	0.5344	0.6149	0.1277	0.3673	0.4253	0.1277	0.8717	1.0000		
	4	3	5	5	4	3	4	4	3	4	4	0	0
LWIN	0.98095	0.26534	0.51185	0.25200	0.11546	0.00000	0.99702	-0.99084	0.00000	-0.99084	0.00000		
	0.1245	0.8290	0.4881	0.7480	0.9263		0.0492	0.0862		0.0862	1.0000		
	3	3	4	4	3	2	3	3	2	3	3	0	0
LSUM	0.09458	0.26643	0.58968	0.36693	0.37453	-0.70352	0.71632	-0.61110	-0.70352	-0.23770	0.00000		
	0.8556	0.8282	0.3017	0.5435	0.6255	0.1849	0.2837	0.1965	0.1849	0.6502	1.0000		
	4	3	4	5	4	5	4	6	5	4	6	0	0
LWIN_SUM	0.72830	0.15579	0.59528	0.38464	0.39747	-0.99050	0.68878	-0.64429	-0.99050	-0.21323	0.00000		
	0.2717	0.8353	0.2896	0.5226	0.6025	0.0878	0.3112	0.3537	0.0878	0.7868	1.0000		
	4	3	5	5	4	3	4	4	3	4	4	0	0

	V_SSAL_A	S_SSAL_A	V_BSAL_A	S_BSAL_A	WINTER	LWIN
WINTER	-0.99999	-0.99999			1.00000	0.97792
	0.0028	0.0028			0.0000	0.0039
	3	3	0	0	6	5
SUMMER	-0.56031	-0.56031			0.95895	0.94764
	0.3259	0.3259			0.0025	0.0141
	5	5	0	0	6	5
WIN_SUM	0.98028	-0.98028			0.98965	0.97562
	0.1266	0.1266			0.0002	0.0044
	3	3	0	0	6	5
LWIN	-0.99084	-0.99084			0.97792	1.00000
	0.0862	0.0862			0.0039	0.0000
	3	3	0	0	5	5
LSUM	0.78452	-0.78452			0.93447	0.97988
	0.1161	0.1161			0.0083	0.0031
	5	5	0	0	6	5
LWIN_SUM	0.99266	-0.99266			0.92083	0.97546
	0.0772	0.0772			0.0092	0.0046
	3	3	0	0	6	5

FAMILY=65

VARIABLE	N	MEAN	STD DEV	SUM	MINIMUM	MAXIMUM
YR_BLT	5	69.40000000	5.94331012	347.00000000	60	76
AREA	4	155.00000000	151.05184747	620.00000000	60	365
DEPTH	6	17.66666667	8.01664934	106.00000000	9	31
DST_SHRE	6	3.36000000	4.18063410	20.16000000	0	11
DST_PASS	4	4.52500000	4.84654236	18.10000000	0	11
DRAIN_VO	3	7028.66666667	1146.84028434	21086.00000000	6367	8352
DST_100F	4	34.47500000	20.55494469	137.90000000	5	58
WIND_VEL	4	11.17500000	0.35000000	44.70000000	11	12
CURR_VEL	3	0.23333333	0.05773503	0.70000000	0	0
V_STMP_A	4	64.75000000	6.99404509	259.00000000	57	74
S_STMP_A	4	84.00000000	0	336.00000000	84	84
V_SSAL_A	3	34.66666667	1.15470054	104.00000000	34	36
S_SSAL_A	3	34.33333333	0.57735027	103.00000000	34	35
WINTER	6	359.33333333	804.81492697	2156.00000000	0	2000
LWIN	5	6.12535048	5.11090120	30.62675239	1	14
SUMMER	7	613.42857143	983.23206097	4294.00000000	0	2101
WIN_SUM	6	1070.83333333	1698.41908791	6425.00000000	0	4101
SSUM	6	9.16569380	5.91041305	54.99416229	3	18
LWIN_SUM	5	11.44535912	5.91407986	57.22679561	5	24

MERGED PHYSICAL AND REDUCED BIO DATA 10 03 THURSDAY, DECEMBER 15, 1983

FAMILY=45

CORRELATION COEFFICIENTS / PROB > |R| UNDER H0:RHO=0 / NUMBER OF OBSERVATIONS

	YR_BLT	AREA	DEPTH	DST_SHRE	DST_PASS	DRAIN_VO	DST_100F	WIND_VEL	CURR_VEL	V_STMP_A	S_STMP_A	V_BTMP_A	S_BTMP_A
WINTER	0.85894	-0.67051	0.95754	0.89685	0.89393	-0.70887	0.30803	-0.41685	-0.70807	-0.04353	0.00000		
	0.1411	0.5322	0.0104	0.0391	0.1041	0.4984	0.6920	0.5832	0.4984	0.9365	1.0000		
	4	3	5	5	4	3	4	4	3	4	4	0	0
SUMMER	0.61573	-0.46938	0.88580	0.91250	0.92024	-0.54597	0.20629	-0.34900	-0.54597	-0.04632	0.00000		
	0.2689	0.5304	0.0191	0.0113	0.0798	0.6323	0.7937	0.6510	0.6323	0.9337	1.0000		
	5	4	6	6	4	3	4	4	3	4	4	0	0
WIN_SUM	0.84894	-0.76030	0.93601	0.92345	0.91996	-0.55447	0.21161	-0.35276	-0.55447	-0.04625	0.00000		
	0.1390	0.4501	0.0192	0.0251	0.0800	0.6258	0.7884	0.6472	0.6258	0.9338	1.0000		
	4	3	5	5	4	3	4	4	3	4	4	0	0
LWIN	0.95450	0.13207	0.64861	0.33987	0.24855	0.00000	0.97746	-1.00000	0.00000	-1.00000	0.00000		
	0.1928	0.9157	0.3514	0.6601	0.8401		0.1354	0.0001		0.0001	1.0000		
	3	3	4	4	3	2	3	3	2	3	3	0	0
LSUM	0.70639	0.02793	0.90855	0.01677	0.72433	0.00000	0.71681	-0.84785	0.00000	-0.84785	0.00000		
	0.2936	0.9721	0.0327	0.9915	0.4843		0.4912	0.3558		0.3558	1.0000		
	4	4	5	5	3	2	3	3	2	3	3	0	0
LWIN_SUM	0.95773	-0.28792	0.87514	0.67467	0.42975	0.00000	0.00048	-0.90894	0.00000	-0.90896	0.00000		
	0.1858	0.7464	0.1249	0.3253	0.5463		0.4992	0.2737		0.2737	1.0000		
	3	3	4	4	3	2	3	3	2	3	3	0	0

	V_SSAL_A	S_SSAL_A	V_BSAL_A	S_BSAL_A	WINTER	LWIN
WINTER	-0.68798	-0.68798			1.00000	0.85944
	0.5170	0.5170			0.0000	0.0619
	3	3	0	0	6	5
SUMMER	-0.53685	-0.53685			0.49227	0.78495
	0.6392	0.6392			0.3275	0.1163
	3	3	0	0	6	5
WIN_SUM	-0.54451	-0.54451			0.89730	0.89453
	0.6334	0.6334			0.0153	0.0405
	3	3	0	0	6	5
LWIN	-1.00000	-1.00000			0.85944	1.00000
	0.0001	0.0001			0.0619	0.0000
	3	3	0	0	5	5
LSUM	-0.84785	-0.84785			0.81334	0.95221
	0.3558	0.3558			0.0948	0.0123
	3	3	0	0	5	5
LWIN_SUM	-0.90894	-0.90894			0.83736	[illegible]
	0.2737	0.2737			[illegible]	0.0068
	[illegible]	3	0	0	5	[illegible]

VARIABLE	N	MEAN	STD DEV	SUM	MINIMUM	MAXIMUM
YR_BLT	5	69.40000000	2.98831012	347.00000000	40	74
AREA	4	155.00000000	151.05186747	620.00000000	40	365
DEPTH	6	17.66666667	8.01664935	106.00000000	9	32
DST_SHRE	6	3.36000000	4.10053410	20.16000000	0	11
DST_PASS	4	9.52500000	4.44456234	38.10000000	3	11
GRAIN_VO	3	7028.66666667	1146.04028434	21086.00000000	6347	8352
DST_100F	4	34.47500000	20.15694469	137.90000000	5	50
WIND_VEL	4	11.17500000	0.35000000	44.70000000	11	12
CURR_VEL	3	0.23333333	0.05773503	0.70000000	0	0
W_STMP_A	4	64.75000000	7.99504509	259.00000000	57	74
S_STMP_A	4	84.00000000	0	336.00000000	84	84
W_SSAL_A	3	34.66666667	1.15470054	104.00000000	34	36
S_SSAL_A	3	34.33333333	0.57735027	103.00000000	34	35
WINTER	6	774.16666667	759.19751629	4645.00000000	6	2000
LWIN	6	9.45544506	4.74178672	56.73267039	2	14
SUMMER	7	1256.57142857	752.72795738	8796.00000000	50	2010
WIN_SUM	6	2738.16666667	1467.88492964	16429.00000000	56	4000
LSUM	7	10.12946063	2.45153487	71.90622433	4	10
LWIN_SUM	6	14.63745041	7.51445301	87.82470244	4	22

CORRELATION COEFFICIENTS / PROB > |R| UNDER H0: RHO=0 / NUMBER OF OBSERVATIONS

	YR_BLT	AREA	DEPTH	DST_SHRE	DST_PASS	DRAIN_VO	DST_100F	WIND_VEL	CURR_VEL	W_STMP_A	S_STMP_A	W_BTMP_A	S_BTMP_A
WINTER	0.92217	0.20792	0.53827	0.49526	0.57501	-0.99719	0.26453	-0.20862	-0.99719	0.27619	0.00000		
	0.0777	0.8667	0.3494	0.3962	0.4250	0.0477	0.7355	0.7914	0.0477	0.7238	1.0000		
	4	3	5	5	4	3	4	4	3	4	4	0	0
SUMMER	-0.01443	0.39320	-0.14550	-0.09818	0.16957	-0.45785	0.03361	0.11137	-0.45785	0.50088	0.00000		
	0.9816	0.6068	0.7833	0.8636	0.8304	0.3444	0.9664	0.8876	0.3444	0.4991	1.0000		
	5	4	5	6	4	3	4	4	3	4	4	0	0
WIN_SUM	0.97394	0.56989	0.32943	0.29427	0.33898	-0.93456	0.12766	-0.01314	-0.93456	0.43030	0.00000		
	0.0261	0.6144	0.5883	0.6388	0.6610	0.2316	0.8724	0.9879	0.2316	0.5698	1.0000		
	4	3	5	5	4	3	4	4	3	4	4	0	0
LWIN	0.85288	0.55650	0.11178	0.31998	0.37754	-0.97398	-0.53643	0.62166	-0.97398	0.90805	0.00000		
	0.1471	0.6243	0.8580	0.5997	0.6226	0.1455	0.4636	0.3784	0.1455	0.0919	1.0000		
	4	3	5	5	4	3	4	4	3	4	4	0	0
LSUM	0.01831	0.47182	-0.39517	-0.23894	-0.05116	-0.68986	-0.58389	0.72333	-0.68986	0.86245	0.00000		
	0.9767	0.5290	0.4381	0.6597	0.9489	0.5152	0.4161	0.2768	0.5152	0.1375	1.0000		
	5	4	5	6	4	3	4	4	3	4	4	0	0
LWIN_SUM	0.49142	0.91681	-0.23103	0.02396	0.09224	-0.83765	-0.73692	0.83735	-0.83765	0.95428	0.00000		
	0.5096	0.2551	0.7085	0.9695	0.9076	0.3679	0.2631	0.1629	0.3679	0.0457	1.0000		
	4	3	5	5	4	3	4	4	3	4	4	0	0

	W_SSAL_A	S_SSAL_A	W_BSAL_A	S_BSAL_A	WINTER	LWIN
WINTER	-0.95029	-0.95029			1.00000	0.71224
	0.0888	0.0888			0.0000	[illegible]
	3	3	0	0	6	4
SUMMER	-0.32929	-0.32829			0.85248	0.86126
	0.7871	0.7871			0.0310	0.0275
	3	3	0	0	6	6
WIN_SUM	-0.67211	-0.67211			0.96236	0.81789
	0.5308	0.5308			0.0021	[illegible]
	3	3	0	0	4	4
LWIN	0.88172	0.88172			0.71224	1.00000
	0.3128	0.3126			[illegible]	0.0000
	3	3	0	0	4	4
LSUM	0.72266	0.72238			0.20020	0.76157
	0.4854	0.4854			0.7037	0.0785
	3	3	0	0	6	6
LWIN_SUM	0.70525	0.70525			[illegible]	0.50652
	0.2294	0.2294			0.7508	0.3057
	3	3	0	0	6	[illegible]