DISTRIBUTION AND COMPOSITION OF SUBSTRATE IN THE LITTORAL ZONE IN JACKSON LAKE, GRAND TETON NATIONAL PARK, WYOMNG

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Introduction and Objectives

The composition of sediments varies both horizontally and vertically in a lake. The distribution of sediment types is related not only to basin geomorphology, but also to the effect of turbulent water as it moves substrate particles in the littoral zone. Definite patterns of erosion and deposition in lakes have been described by many limnologists (e.g., Hutchinson, 1957; Spence, 1982; Keddy, 1982, 1983, 1984). Sedimentation and the quality of sediments as a nutrient source affect the ability of macrophytes to colonize and persist in the littoral habitat. The ability to root in a particular area is directly related to the extent which a substrate can anchor the potentially large plants (Spence, 1982). On erosional shores, suspended sediments abrade rooted plants and may cause damage and breakage. On the other hand, the macrophyte community stabilizes bottom sediments and their presence leads to increased water clarity as particulates settle out due to reduced water currents within plant beds.

Since the relationship between plants and sediments is well known, our objective was to measure the distribution and composition of the sediments in the littoral zone of the lake. Then we could relate the distribution of substrate to the distribution we had measured for macrophytes in the littoral zone.

Methods and Results

Due to an unusual drawdown during the summer of 1985, much of the littoral zone that was under water during the survey in 1983 was exposed. So, we were able to more easily measure the composition of substrate on transects originally used for measuring the cover of submerged macrophytes (Figure 1).

The original transects were relocated by referring to USGS topographic maps we had marked in 1983 and by looking at photographs taken at each transect location. A transect line was placed as close to the original location as possible. Usually, the transect still extended for several meters below the water's surface. Twenty quadrats were systematically assigned to the transects. Percent cover for six categories of substrate was measured on each transects with Daubenmier frames. The substrate categories were based upon size (Table 1).

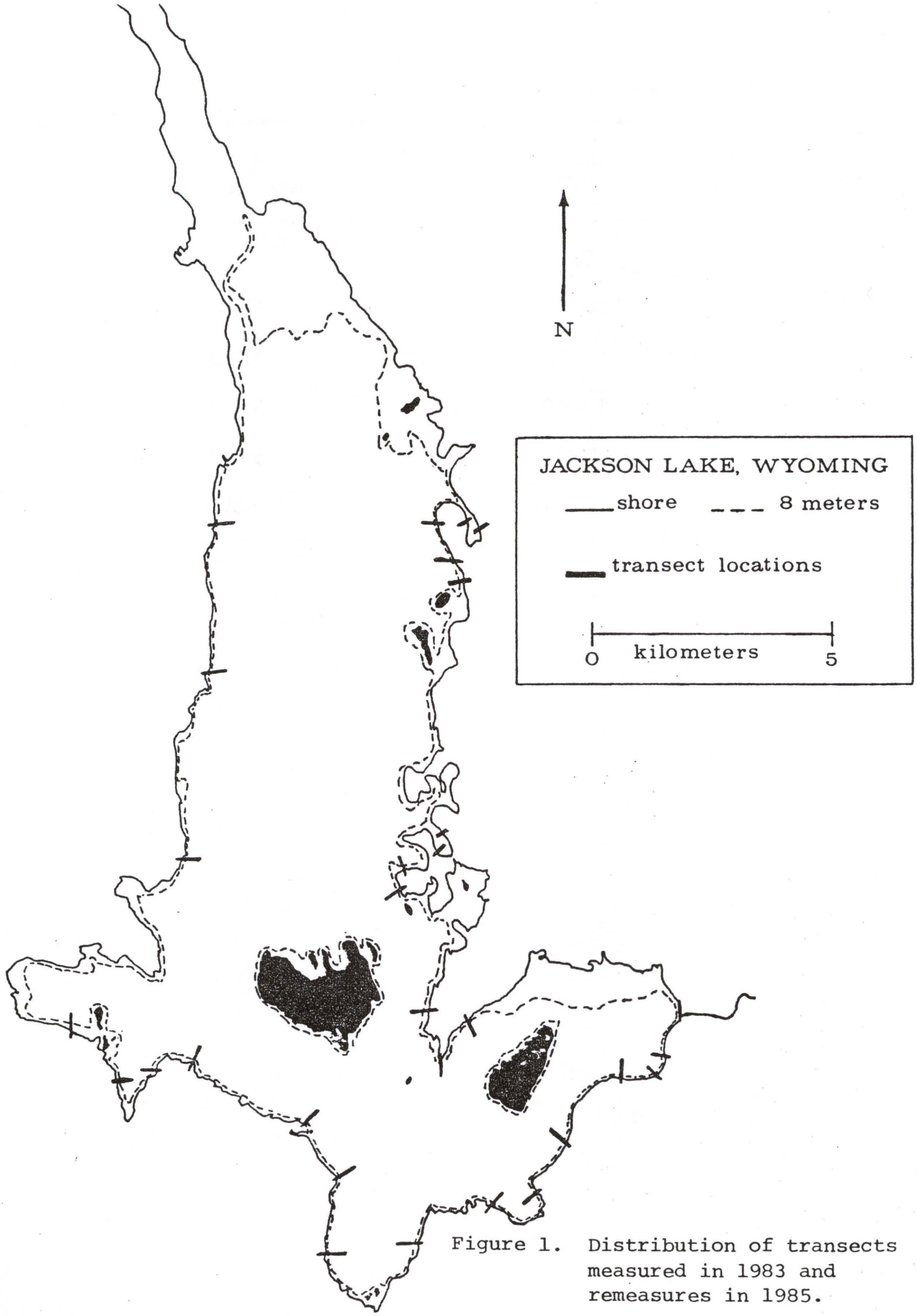

Figure 1. Distribution of transects measured in 1983 and remeasures in 1985.

Table 1. Table of Substrate Sizes.

CATEGORY	NAME OF CATEGORY	SIZE OF PARTICLES
1	SILT	< 1mm
2	SAND	1mm to 5mm
3	SMALL GRAVEL	0.5cm to 3cm
4	LARGE GRAVEL	3cm to 6cm
5	ROCK	6cm to 30cm
6	BOULDER	> 30cm

Measurements were made first on the quadrats located above the water line. Then any quadrats located below the water line were measured by SCUBA divers. We found that visibility could be maintained if the divers began measuring percent cover in the deepest water and moved towards shallower water. Also this method for measurement helped the divers stay a little warmer because they moved from colder into warmer water.

Data were recorded on waterproof writing boards with grease pencils as observations were made by divers. Then these data, along with other relevant observations, were recorded onto field data sheets after the dive was completed. At each transect the following information was recorded: percent cover of each size of substrate; presence of plants; a photograph of the location was taken; the site was located on a USGS topographic map; and length of the transect (the length to reach a depth of 30 feet varied). Relationships between all the substrate and physical variables were determined with the Pearson Correlation analysis using SPSS (Nie, et al., 1975) and the results are presented in Table 2. Depth explains more of the variation in percent cover for all types of substrate, overall, than either the slope of the littoral zone or exposure to water movement.

Analysis of variance (ANOVA) was used to determine relationships between substrate cover and a variety of physical variables. The treatments for this analysis are depth, slope and habitat type and these treatments were used to test whether substrate cover varied. The BMDP statistical software programs P1Vand P2V (Dixon et al., 1985) were used to run the analysis of variance. The results are summarized in Table 3. The mean values for percent cover for each substrate type are separated most clearly by depth and slope. Exposure did not reveal much about the distribution of sediment types in the littoral zone.

Conclusions

Currently, the data for substrate composition are being used to clarify the distribution of macrophytes measured during the summer of 1983. The results from our three seasons of field and laboratory work are being synthesized for the final report to be published during the Spring of 1986.

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Literature Cited

Dixon, W. J., L. Engelman, J. W. Frane, M. A. Hill, R. I. Jennrich, and J. D. Toporek. 1985. BMDP Statistical Software. Univ. of CA Press, Los Angeles.

Table 2. Results of the correlation analysis between substrate variables and physical variables. The first value denotes R (the correlation coefficient) and the second value is the significance of the correlation. NS indicates not significant at $p \leq .05$.

SUBSTRATE CATEGORY	SLOPE OF THE TRANSECT	EXPOSURE	DEPTH
SILT	-.26, .001	-.30, .001	.54, .001
SAND	NS	-.13, .05	.18, .01
SMALL GRAVEL	.17, .05	NS	-.52, .001
LARGE GRAVEL	NS	.21, .01	-.29, .001
ROCK	.27, .001	.46, .001	-.23, .001
BOULDER	-.16, .05	NS	-.29, .001

Table 3. Summary statistics of the analysis of Variance for the substrate data. The null hypothesis tested is that the means for substrate cover in each treatment are equal. The alternate hypothesis is that the means for the substrate cover in each treatment are not equal.

SUBSTRATE CATEGORY	DEPTH df = 4,140	EXPOSURE df = 2,142	SLOPE df = 5,139
SILT	***	***	***
SAND	NS	NS	NS
SMALL GRAVEL	***	NS	NS
LARGE GRAVEL	***	**	*
ROCK	**	***	***
BOULDER	NS	NS	**

* $p \leq .05$; ** $p \leq .01$; *** $p \leq .001$

Hutchinson, G. E. 1957. A treatise on limnology. Volume 1: Geography, physics, and chemistry. John Wiley and Sons, New York.

_____. 1975. A treatise on limnology. Volume 3: Limnological Botany. John Wiley and Sons, New York.

Keddy, P. 1982. Quantifying within-lake gradients of wave energy: interrelationships of wave energy, substrate particle size and shoreline plants in Axe Lake, Ontario. Aquatic Bot. 14:41-58.

_____. 1983. Shoreline vegetation in Axe Lake, Ontario: effects of exposure on zonation patterns. Ecol. 64:331-344.

_____. 1984. Quantifying a within-lake gradient of wave energy in Gillfillan Lake, Nova Scotia. Can. J. Bot. 62:301-309.

Nie, N. H., C. H. Hull, J. G. Jenkins, K. Steinbrenner, and D. H. Bent. 1975. Statistical Package for the Social Sciences. McGraw-Hill, Inc., New York.

Spence, D. H. N. 1982. The zonation of plants in freshwater lakes. In: Advances in Ecological Research. Edited by A. MacFayden and E. D. Ford. Acad. Press, London.