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Release of Sediment-Bound Fecal Coliforms by Dredging[1]

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Fecal coliform concentrations increased significantly (F test) in the immediate vicinity of a maintenance dredging operation in the Mississippi River navigation channel. Increased counts were attributed to the disturbance and relocation of bottom sediments by dredging and a concomitant release of sediment-bound fecal coliforms.

During the 1930's, the U.S. Army Corps of Engineers constructed navigation locks and dams in the Upper Mississippi River, thereby converting it into a series of navigation pools. The Corps has since operated these lock and dam facilities and has, through dredging, maintained the navigation channel at a depth to accommodate 2.7-m draught vessels. Recently, maintenance dredging has received much criticism because of the adverse environmental impact of current Corps dredge spoil deposition procedures. One aspect of dredging that has not been adequately investigated is the relationship between sediment disturbance and release of sediment-bound materials to the overlying water column. Since indicators of fecal pollution and enteric pathogens have been shown to persist in bottom sediments (3, 5), the relationship between dredging and bacteriological water quality was investigated. This note describes a study which examined membrane filter fecal coliform (FC) densities in a relatively nonpolluted reach of the Mississippi River prior to, during, and after a large dredging operation during the summer of 1973.

The study area (Fig. 1) was in the vicinity of Crosby Island, a 32-hectare island located 12 km south of La Crosse, Wisconsin at river mile 690.0. Crosby Island served as the deposition site for spoil obtained from a 100,000-m^3 cut (Fig. 1) made by the Corps' dredge William A. Thompson. Grab samples of water were collected at approximately 40 cm below the surface at each of 40 sampling stations (Fig. 1) on four different occasions: 15 June, 4 days prior to dredging; on 19 and 22 June, the first and last days of dredging, respectively; and on 27 June, 5 days after completion of the dredge cut. All samples were immediately processed onboard the Department of Biology's 50-ft Research Vessel Izaak Walton. Prescribed membrane filter FC procedures (1) were employed, membrane filters (Millipore Corp.) were plated on mFC broth (Difco), and plates were immediately placed in an onboard 44.5 C water bath.

Table 1 lists the results of the four FC determinations made at each station. FC densities on either side of Crosby Island adjacent to and downstream from dredging operations (Fig. 1) were significantly higher during dredging than before or after. Similarly, FC densities for stations 23 through 33 (Crosby Slough, Fig. 1) were elevated during dredging. A time series analysis of variance between the four sample mean values (Table 1) revealed that the observed differences were significant at the 99% level, as evidenced by an F value of 26.451 (at the 99% significance level with 3 and 155 degrees of freedom, an F value ≥ 2.668 would be significant). Origin of the FCs observed in the study area would include those known point sources listed in Table 2, as well as several potential nonpoint sources of pollution (e.g., agricultural runoff and abundant wildlife).

These data indicate that disturbance and relocation of bottom sediments by dredging results in a concomitant release of sediment-bound FCs. The greatest elevation in FC densities existed on the channel side of the island, immediately downstream from dredging operations, and in Crosby Slough. This probably resulted from a combination of three factors: (i) the bottom type in the channel, (ii) the direction of channel and backwater currents, and (iii) a dilution effect. The channel bottom is predominantly sand, and sand has been shown to serve as a natural attachment site for benthic bacteria (4). Since sand adsorbs bacteria very loosely (2), most, including FCs, would probably be released to the water during initial sediment disturbance by the dredge cutter blade. Once in the water, large numbers of bacteria would be carried by currents, where a

[1] Contribution no. 4, River Studies Center, University of Wisconsin-La Crosse.

TABLE 1. *Membrane filter FC densities as determined 4 days prior to dredging (15 June), on the first and last days of dredging (19 and 22 June, respectively), and 5 days after dredging (27 June)*

Station no.	Location[a]	FCs per 100 ml			
		15 June	19 June	22 June	27 June
1	Channel side	41	81	66	56
2	Channel side	32	50	46	62
3	Channel side	56	130	54	72
4	Channel side	38	64	50	
5	Channel side	26	76	70	78
6	Channel side	28	120	100	58
7	Channel side	72	150	110	60
8	Channel side	84	140	88	44
9	Channel side	65	200	110	46
10	Downstream	33	170	92	58
11	Downstream	71	91	120	54
12	Downstream	35	73	91	48
13	Backside	29	67	110	38
14	Backside	35	73	71	56
15	Backside	21	55	48	80
16	Backside	19	74	52	98
17	Backside	27	92	73	86
18	Backside	21	81	50	86
19	Backwater	29	50	41	64
20	Backwater	33	71	48	98
21	Backwater	48	79	58	48
22	Backwater	85	71	66	56
23	Crosby Slough	30	170	65	48
24	Crosby Slough	28	170	59	64
25	Crosby Slough	40	130	73	80
26	Crosby Slough	25	130	69	82
27	Crosby Slough	40	94	70	46
28	Crosby Slough	51	81	89	54
29	Crosby Slough	35	75	75	62
30	Crosby Slough	45	110	53	56
31	Crosby Slough	30	94	68	48
32	Crosby Slough	52	110	57	56
33	Crosby Slough	64	92	36	62
34	Backwater	50	42	36	36
35	Backwater	73	74	73	72
36	Backwater	50	86	72	75
37	Backwater	65	84	63	18
38	Backwater	65	42	46	54
39	Backwater	42	55	39	42
40	Backwater	55	63	36	48
Mean value		44.2	94.0	67.3	60.2

[a] Location relative to Crosby Island (see Fig. 1).

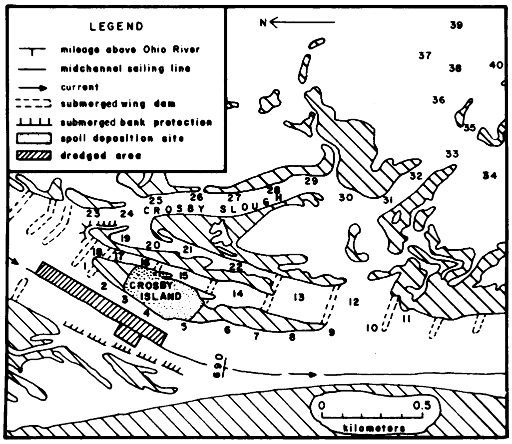

FIG. 1. *Map of Crosby Island and adjacent areas, with the location of sampling stations indicated by number.*

TABLE 2. *Known point sources of FC input upstream to the study area*

Source	Confluence[a]	Discharge[b] (m^3/s)	FCs per 100 ml
La Crosse River	698.2	5.3	2,800[c]
Treatment plant	697.0	0.5	23[d]
Root River	693.7	18.1	NA[e]

[a] Point of confluence with the Mississippi River. Expressed in miles above the Mississippi River-Ohio River confluence at Cairo, Ill.

[b] Average discharge.

[c] Arithmetic mean of 12 weekly determinations made by the City Health Department, La Crosse, Wis.

[d] Geometric mean FC concentration of chlorinated, secondary effluent. Value provided by the Wastewater Treatment Plant, La Crosse, Wis.

[e] NA, Not available. Land use of Root River Basin is agriculture, especially dairy farming.

lesser number would be pumped to the deposition site. The prevailing current (Fig. 1) is that of the main channel (average discharge is 700 m^3/s), although a strong current also runs southwardly through Crosby Slough. The current running past the backside of Crosby Island is diminished by wing dams (Fig. 1). Therefore, the elevated counts observed for stations 1 through 11 and 23 through 33 (Fig. 1 and Table 1) are best explained by current-directed movements of FCs released during dredging. The somewhat lower densities observed on the backside of the island probably resulted from a dilution of those FCs that were pumped to the deposition site. Specifically, dredging requires tremendous volumes of water to pump spoil (4 m^3 of water are required to move 1 m^3 of spoil) and this would tend to dilute the concentration of FCs reaching the deposition site. Hence, FCs reaching the backside of the island would have a lower concentration both because of dilution and because of current-mediated removal.

In conclusion, it must be emphasized that observed FC densities probably did not indicate a health hazard. The highest count obtained was 200 per 100 ml at station 9 during the first day of dredging. However, public health implications of this study are clear; maintenance dredging of bottom sediments heavily contaminated with enteric pathogens could produce a temporary health hazard in downstream recreational areas. For this reason, it is imperative that studies be undertaken to elucidate the effect of dredging bottom sediments known to harbor enteric pathogens.

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