# CEER-M-133

?48 ENVIRONMENTAL EVALUATION OP LA PLATA EARE, TOA ALTA

SECOND QUARTERLY REPORT (JAN,-MAR., 1962)

CENTER FOR EWERGY AND ENVIRONMENT RESEARCH

MARINE ECOLOGY DIVISION

COLLEGE STATION

MAYAGUEZ, PUERIO RICO

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AN ENVIRONMENTAL EVALUATION OF LA PLATA LAKE, TOR ALTA

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?Total Suspended Solids vs. Depth at Lake Station z-1,

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Total Dissolved Solids at Tributary Stations.

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Armonia-Nitrogen vs. Depth at Lake Station In.

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Concentrations of Heavy Metals vs. Depth at the Lake

Station, L-Z.

Concentrations of He

wwy Metals at Tributary Stations.

Concentration sof Selected Mater Quality Paraneters vs.

Depth at the Dam Site Station during February 4, 1982,

Comparative Analysis of Average Water Colunn Concentrations

Of Selected Water Quality Paraneters Between Z-1 and the

Dam Site.

Surface Plow Measurements of the Major Tributaries of La

Plata Lake.

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?his document is @ report of work accomp)ished during the second quarter of the restoration-diagnostic/feasibility study of La Plata Lake, Included are the results and preliminary analyses of the date collected during routine sampling excursions to the study area which correspond to the months of January, February and March, 1982, and ?an ad@itional sampling event performed on 4 February 1982.

?The information which resulted from the first quarter of the study (Oct-Dec., 1981) provided a general indication of the major water quality problems of La Plata Lake. These were identified as hypolinnetic oxygen depletion, eutrophication, choking of the lake surface by water hyacinths and bacterial contamination above accepted surface water standards for Puerto Rico. As part of our initial objectives the potential inputs of lake vater quality degradation were identified by our approach of measuring concentrations at tributary rivers and at the lake proper. The results evidenced that ?the loading of nutrients, suspended solids and bacteriological contaaination were contributed by the main tributaries of the lake. We also indicated that in view of the fact that more than 909 of the water entering the system comes from the watershed drainage. of La Plata River particular attention should be addressed to this txibutary in tems of the potential sources of contamination origi-

nating from its drainage basin.

---Page Break---

Our approach during the second ?quartce (Jan-Mar) of the stuly has followed the original samplinc stcategy of measuring concentrations at the main tributaries (La Plata River, Guadiana River and Cafas River) and at one station in the lake proper in order to provide the basic characterization of the lake as an input-output system. During ?is quarter we included in our sampling scheme @ special investigation Girected to evaluate our present monitoring station (I-I) as indicax tive of the water quality of the lake proper by comparing the water ?column average concentrations of I-I with the average water coluan woncantrations at the dan site where the intakes of water for public

supply are located, As part of this analysis our ability to detect
field differences in concentrations for most of the paraneters studied
was determined.

4m general, the results from this second quarter of investigations
Provide a more solid indication of what is the natural pattern and
Structure of some of the most important lake features, such as ite
?thermal and chenical stratification, biological response to nutrient
Joading and the importance of the morphometric structure in dictating
?the present lake water quality condition.



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wericus

No Getailed prescntation of methods is made, the reader is

Feferred to the proponeh and quality assurance documents for that

Anformation.

resus

?he analytical results from vater samples collected for » total

°F 32 water quatity pacaneters during the perio? between January and

March, 1902 are presented in Tables 1 through XX. ?The concentra

tone of

ected water quality paraneters resulting fron a single hyarocast at the dam site are presented in Table 20XVI. Table xeXVI1 Presents a comparative analysis of average water column concentrations Between the lake station L-I and the auxiliary station at the dam

site. Surface flow measurements taken at La Plata major tributari:

are presented in Table xowvit1,

?ater samples for a preliminary screening of synthetic organics have been collected and the results will be reported as an addendun ?of the present report. Also included as an addendum of the present report will be the results of ig concentrations and phytoplantton femmeration and taxonomy for the months of January, February and March, 1962.

---Page Break---

Figure I. Sumting te lata ike and mato

Autiliary station

D1 Dam Site

Monitoring Stations

Wl ua Plata River

W-2 Guadiana River

W3 cans River

Int Lake Station

SCALE 1:20,000

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TABLE I. Water Temperature voy that Loke Station ber

s/3ya

sc

25.6

25.2

25.0

2ale

2a6

24.4

24.2

24.0

23.8

23.5

10 23.2 23.2 23.3 23.4

u 23.2 23.2 23.3 2313

az 2a 23.1 23.2 23.2

a 232 23.0 23.2 23.2

aa 23.0 23.0 2a 23.2

a5 23.0 23.0 2a aaa

16 23.0 22.9 23.0 23.4

co 2219 2219 23.0 232

18 22:9 22.9 23.0 23a

19 22.9 2219 22.9 232

20 22 22:9 22.8 23a

a

?TABLE 31, Water Temperature at Tributary Stations.

SAMPLING DATES,

azye2 2/13/82 3/3/82

Stations. tc sc sc

Wet La Plata 23.6 24.0 23.5

W-2 Guadiana 22.8 27.0 23.7

W3 Cafas 23.0 aa 20:5

a

oS

---Page Break---

TALE I11._Diseotved

cvgen.

an2yaa 4/8 2yniye2 sy3/e2

bepth im) gd nas Bo/t 1ng/i.

TABLE IV. Dissolved Oxygen at Tributary Stations.

SAWPLING DATES

anzye2 2/ayer 3/3/82

Stations ag/t gL g/t

Wer Le Plata 6 8.0 1

2 Guadiana on 20.2 30.0

W-3 caflas 8.79 9.4 8.3

---Page Break---

Bie. bepeh at

DATES

2/aye2 3/3/82

Units unite

aazye2

Depth im) Units

65.

5

4

4

4

4

4

14

4

SSS

TABLE VI. pl at tributary Stations

i nk tebe Stat sone

SMELING DATES

a/12/e2 ain/e2 3/3/82

Stations, Unite Units Units

Wt La Plata 8.0 7.9 7.9

W-2 Guadiana 79 7 re

W-3 Cahae 7 7 r6

SS

ABLE VIL, Secchi Disk Readings at Lot and tributary Stations.

SAMPLING DATES

32/82 2/aye2 2yaa/e2 3/3/82

Station ~) (=) (a) (a)

1 2.0 1.25 1s.

wa 2125 013 0.75

we 2008.50) 100¥(.5a) 1008.5)

w3 2008(-4m) 2008" 4n) 1008 4m)

Musber_in parenthesis represents total depth of station.

---Page Break---

aur v:

Sonduceivit

ake Stat

tet

?? ?SAMPLING DATES

avazvez 2/4/92 2yaaaz 33/8:

Depth ia) imnoe/es uhos/em tmhos/en____unhos/ex

° 262 305 348 aaa

a 262 305 348 ae

2 261 306 349 314

3 252 305, 347 313

4 248 294 333 32

5 224 236 327 a2

6 27 279 a 308

7 a3 263 309 299

8 208. 250 300 287

9 201 232 261 265

a0 195 26 244 24a

n 109 206 234 227

2 186 193 ae 29

13 382 ies 208 213

14 17% 205 198 2a

as 170 181 192 206

36 166 179 189 203

uv 164 176 363 201

18 162 176 162 196

19 157 a7 179 191

20 153 167 a7 189

ARLE 1X, Conductivity at Te Stations

Sas ete tiey Statens

swoume pares

3/12/82 2/11/82 3/3/82

Stations imhos/en umhos/em uimhos/em

Wt ta Plata 364 290 23

W-2 Guadiana 280 300 305,

W-3 Cahae 310 as 320

---Page Break---

tion Ley

zraye2 373/82

g/t oi

5.4 se

6.2 3.0

2.0 28

a4 98

23.4 20.6

21.6 25.0

FABLE XL. total suspended Solids at tributary stations.

SAMPLING DATES

anzye2 2nnyer 3/3/82

Station alt g/t ng/t.

wa sa 29.6 on

we 12 5.6 16

ws 55.2 16 °

FABLE MIL, Total Dissolved Solids vs. Depth at take station z-1

SAMPLING DATES

an2ys2 2/478: 2yarysz 3/3/82

htm) 7 ve 7 Vs

° 203 187 190 198

? 481 174 a2 362

8 480 205 186 362

2 23 as 200 166

16 27 236 195 106

20 136 208 202 77

_?,_

-s

---Page Break---

wa

m3

TAME IV. total alkalinity vs. pepth at Lake Station 1-1.

SAMPLING DATES

| | 3n2/e2 | 2/4/02 | 2/11/82 | 3/3/82 |
|---|---|---|---|---|
| Depth i=) | mg/tcaCo, | ng /ECaCo, | ms/tcaco, | _ma/tcaco, |
| ° | 94 | us | 132 | 120 |
| 4 | 86 | na | 123 | ne |
| a | n | 96 | 120 | ue |
| a2 | us | 76 | 85 | 93 |
| 16 | 6 | 66 | 69 | 8 |
| 20 | 8 | 63 | 66 | n |

FABLE XV.__Total Alkalinity at Tributary stations.

SAMDLING DATES

1/az/ez 2/11/82 3/3/82

Stations 9/taC0, 9/200, g/taco,

wa 142 105 143

we 302 a3 <8

ws 106 315 122.5

–'–

=10-

---Page Break---

epee Station ton

SAMP.ANG DATES

2/ayez annye2 3/3/82

na/h ?na/t g/t

o 04 -o1

93 03 02

206 as 05

2 01 os 218 a9

a6 <0 as 216 2

20 03 28 233 os

ee

ABLE XVII. _Annonia-Nizrogen at Tributary stat ions.

a ci toon gt Tesbutary Stations.

?SAMPLING DATES

waz/ez 2payez 3/3/82

Station g/t mg/h g/L

wr 02 08, os

we 01 02 202

ws 01 on 02

Sa

FABLE WILL. _Miteite-Witrate vs. Depth at Lake Station 1-1.

SAMPLING DATES

a/n2/e2 2/aje2 2/2 3/3/82

ta) ft Ve mg/t Ve

° 66 16 8 a

4 85 213 ey

1.23 38 58 4

a2 a2 79 7 238

16 1.07 aoe 73 4

20 1s ?56 a 04

SS

one

---Page Break---

SUE MIX. Natrite-t Stations.

S26P-ANG BARES

nzez wn ata? 3/3/82

Stations mgt g/t g/t

wr 1.07 aa oo

w2 1.82 1.82 a8

ws 1.87 1.62 a4

ABLE XX. Total Kjeldahl Nitrogen vs. Depth at Lake Station LAT.

SAMPLING DATES

3/12/82 2/4/82 2naye2 3/3/82

Depth > na/t 9/2, ng/t rng/t

° ?5 68 23 38

? ?41 ?68 as +50

e 65 68 26 38

a 79 133 ?33 58

16 a ?65 -70 79

20 75 1.08 a 98

SSS

ABLE XXr.__Total Kjeldahl Nitrogen at tributary station

SAMPLING DATES

4zyez 2/11/82 3/3/82

Stations aa/k aa/t mg/h

wea 29 30 34

we -30 23 38

ws 28 18 28

a2

---Page Break---

FABLE 200%. Soluble Reactive Phos: horse vi. Depth at Lake Station int

SRE Salus Resctive Phos tors vi. Depth at, a

SAILING DATES

az: 2a: ayer syayez

Pepehie) g/t mg/kg gt

° 20 wot 10 205

? -2 wo8 08 206

8 a2 10 ne 09

2 a4 a6 a5 23

36 33 a6 a5 3

2 aa 12 235 a

eee

TABLE XXIZI. Soluble Reactive Phosphorus at Tributary Stations

SE Sails Resctive Phosphorus at Tributary stations

?SAMPLING DATES

aazyez 2/11/82 3/3/02

Stations no/t ing/t a/t

wa -19 26 26

we 20 28 223

w3 a3 ?2 -10

eee

FABLE DOUV. Total Phosphorus ve. Depth at take Station 1-z

Sees trcephorvs ves Depth at bake Station tet

SAMPLING DATES

asiayez 2yaye2 2/11/82 3/3/82

Depth im) g/t g/t g/t g/t

° 53 as ae er

+58 a as 238

8 a7 3 ary a4

2 29 0 a3 as

16 20 20 a7 2

20 7 26 as ?10

as

-

---Page Break---

TABLE xv.

wazse2 yrye2 sys/e2

Stations aft ait

wa 7 26

w2 38 232 28

ws 218 38 as

eee

ABLE XXVI._Chlorophy1J-a ve. Depth at Lake Station 1-1

SEE Sorophytina ve._Depth at Lake station tet

SAMPLING DATES

anzge 2/a/e2 2nrse2 3/3/92

Depthim) g/m ag/ad mg/m ag/n?

ON

° aaa 29.51 34.98 3.07

4.65 18.98 a.az 2.69

68 48 3.04 3.03

a 123 1.20 2.03 2.98

26 32 2.09 2.39 16.60

20 26 1.46 1.04 13.09

?

FABLE Dvr. Chlorophyli-a at tributary stations

SAMPLING DATES

3/12/82 2/a1/e2 3/3/82

Stations g/a3 ?ag/a3 g/m?

wa 1.2 1.30

oot 1.87 2.03

wo 3.06 6.35

ee

---Page Break---

ABLE sows.

al Colifoms vs. Depth at fake Station Let

2/azye2 2nayez 3/3/82

Depth in) MP /100 mis _Mpn/i.00 mis MPH /100 mis

° 1,400 2,700 790

4 490 790 79

® 230 700 130

2 170 . 230

26 130 700 230

20 50 1,700 130

?Sample bag accidentally torn during transport.

ee

TABLE XOX. Total Coliforms at Tributary stations.

SMOLING DATES

a/zyez 2/11/82 3/3/82

Stations, MEN/100 mis MPN/100 mle 12% /100 mis

pa 1,500 1,815 640

we 24,450 7,950 1,300

ws 3,850 7,650 2,800

?

TABLE XXX. _Pecal Coliforms vs. Depth at Lake station in

?SAMPLING DATES

wafer 2y1/e2 3/3/82

) Men/100 ais MPN/100 mls MPN/100 21s

° 210 230 3

? 490 490 9

230 700 3

2 20 . 79

16 80 330 49

20 20 230 9

?Sample bag accidentally torn during transport.

ee oeoeoeOeNw ees eee

a5

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Sea} Co) iforns at Tritt

sanr.tme

a2pe2 2/31/82

Stations MoW/100 mis MPN/100 ns

wt 220 965,

we 1,400 3,300

wa 640 94s

FABLE 2O0UT. Fecal streptococcus vs. Depth at Lake Station t-1

SQNPLING DATES

°

?4

e

a

16

20

a/n2/e2 2/11/82 3/3/82

Depth im) MEN/100 mis. MEN/300 mis 44/100 mie

80 13 2

<0 94 @

?90 130 2

20 . 5

0 n10 5

20 a 2

?Semple bag accidentally torn during transport.

SSS

FABLE 200UTT. _Pacal s: cus at tr: Stations

TARE RO ree Seieptosoeos at Tributary Stations

SAMPLING pares

ayr1e2

MON/100 mis

Stations

wa

wa

3/2/02

20n/100 ae.

3s

465,

345

92

6

360

3/3/82

s2n/100 mls

a0

475

3/3/02

MEN/100 mis

18

23

140

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er 90" 90" oe wet wr ee, a

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+ (euoygexquesu9 oBez0ae 1-2)

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oe woro ove vse as

we 90° oro abe xf

oe vem 65-0 wo 1/68 Fon-Fow

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ws - ven Soro er ays ora

wore seve see sana us

- v0 20 ee wojsoinet ??_ayatyonpuog

ocee - sere sez wee 2 omaezedang

TE OPENS TTS BT ? RTT FTE ara TR oeTE

worserzen 30

Tous wa Ba poe ToT usenieg eiosouvied Mar TenO

aye pezseT9g 30 suoyzexqU2UED UmNTOD 783ey eBETeay Jo STSATEUY SAFyeTedUCD

?TTAXKX STEVE

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spomnseau 30H -

Taye wavla Pr 30 Bai

jTavangyal A0feH wa Jo SsuSMeTNECOR AOTE OOUFINS TTTAM STEVE

20-

---Page Break---

?The vertical profile of water temperature evidenced a gradual Gocline with depth at the lake station I-r (see Table 1) with an average AT of 0.15°C per meter. The maxinun differences in water tenperature between surface and 20 m depths were 2.7°C in January, 1982 and averaged 2.5¢C during this quarter (Jan.-Mar., 1982). The plane Of highest rate of change with depth fluctuated between surface and 6m depths. ?The presence of a classical thermocline (i.e., A7> 1°/M) Was not evident at any depth in the vater column; however, the tenperature Profiles reveal a weak thermal stratification.

Water temperatures at the main tributaries ranged between 23.5°C and 24°C in La Plata River (W-1), 22.8°C and 27.0°C in Guadiana River land 20.5°C and 23.0°C in Cafas River (see Table 11).

Dissolved oxyger

A clinograde oxygen profile was maintained at the lake station

11 during the period between January and March 1992. A strong chenocline fluctuated between 2-4 m (see Table ILI). Oxygen depletion with zero values in the hypolimnion has been sho to be a recurrent lake feature in La Plata Lake (eee First Quarterly Report).

?The structure of oxygen distribution in La Plata Lake is-dictated by complex biochenical, physical and hyarodynanic factors. ?The major features are probably: lake morphometry, nutrient loading and bio~

logical response, possible organic loading, and the tropical setting.

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?The lohw has u relatively low surtace to volume selationship (relative depth s© .04) and Ate location protected by high hills tends to prevent wind mixing und reaecation, toading of the Lake by Nand P via rain-runoff is high and sustains a higher internal primary productivity. Phytoplankton resgond with densities so high in surface waters that light penetration is restricted. Water hyacinth erops are high an cover more than SO% of the lake surface. Where Present, they virtually screen out all the Light. organic materials Aischarged to the lake in rain events and sédimenting phytoplankton and dead particles of hyacinths support the growth of microbes which consume available oxygen in the layers of the lake below 4-6 meters fand render it anaerobic and reducing. Such reducing conditions, in general, are unfavorable for the growth of phytoplankton and other serobic life. Thus photosynthetic exygen renewal does not occur either.

The large seasonal reductions in temperature, which in more

temperate areas result in convective mixing of the water column,

@o not occur here and the higher and less variable temperature regine

keeps metabolism high while preventing physical reaeration.

Tributary discharge and runoft of well-oxygenated vaters

lave shom to be a significant factor in the oxygenation of the

water column in Lake La Plata; however, it appears possible that

only rainstorm events or extremely strong winds will be capable of

mixing the lake restoring oxygen to the depths. Some restoration

?of oxygen to the hypolimnion was evidenced following the rains of



---Page Break---

December, 2981 but p: aved to b of shart duration as clinograde profiles again eppeaed from J.nusry thioush March, 1982

Onygen deptetio: in lake waters represents a serious water

Quality and recreaticnal problem in ta Plata Lake. Neavy metals

such as t?* and Fe are nore soluble under anoxic conditions and

could be detrimental to the system as a drinking water supply; also,

fisheries of any sort are Limited by oxygen deficiences. In view of

this finding increased attention will be addressed todissoived oxygen

structure and lake metabolism in the next quarter of the study.

Dissolved oxygen concentrations at tributary stations were all

well-onygenated with values near to saturation (eee Table Iv).

Pt

Protiles of pit at the lake station In1 are presented in Table v.

?The pil was consistently higher in the first two meters with an average

©f 7.0, then declined gradually with depth to mean values of 6.55 at

20m. The phytosynthetic removal of CO, from the uppermost (Lighted)

layers of the lake are postulated to be involved in the maximum values

observed. However, tributary rivers gave higher pil values than the

Lake (means of 7.9 in ba Plata, 7.8 in Guadiana and 7.7 m in Cafas,

(see Table VI) allowing the alternate explanation that those input

waters simply dominate the upper layers of the lake.

Secchi Transparency .

?The average secchi trancparency at the lake station I-I was

1.4m. Monthly secchi readings at Int reflected significant inverse relationship with mean epilinnion zone (0-4 m) values of total sus-

ended solids (r= -.96). Secchi disk readings at 1-1 and tributary

stations are presented in Table VII.

---Page Break---

Conductivity

?The average condvetivity of the water colunn at the lake station

(1-1) was 232 umhos/em per meter. ?Tho maximum rate of change was found between 7 - 11m (% = 13.4 ymhoc/on/m). The vertical gradient continues to show no relation to total dissolved solids suggesting that vertical Aifterences in ionic species must exist in the water column. The re~ lationship of specific conductance to TDS will vary depending on the Aistrinution of the major chemical species present (Mater Quality Criteria, 1973) and conductivity is, to some extent, influenced by the size ané nature of suspended particles as well.

?special sampling and analyses will be performed in the next quarter to examine the possibility that non-ionic dissolved organics contribute

4 larger fraction of 705 at depths than near the surface.

?The specific conductance of the tributaries continue to be higher than the lake. Tributary rivers (Table Ix) had mean conductivities of 309 \mhos/en at La Plata (W-I), 295 ymhos/on at Guadiana and 315 jahos/

om at Calas River.

Totad Sols

?The vater column mean of TSS for the period between January land March, 1962 was 58.6 mg/L. ?The vertical profile maintained = consistent increase with depth during this quarter (see Teble x). Considerable variation resulted between the month of January and tthe months of February and March, 1982. Higher concentrations of TSS in ganuary were associated with high sediment Joading to the Lake Guring December rainstorms. Tributary rivers presented mean con

centrations of TSS of 14.6 mg/t in La Plata, 2.0 mg/f in Guadiana

---Page Break---

and 18.9 mg/L in Callas (see Toble Xi). Although Cafas River Presented higher concentrations of TSS, the leading of sediments via La Plata was greater by virtue of relatively much larger flow:

?As previously shown by spatial variability studies (see First Quarterly Report) horizontal gradients develop in the La Plata am of the lake apparently as a result of La Plata River inputs.

Total Dissolved solids

WS averaged 215 mg/L in the water colan at I-T. Te vertical profiles of February and March, 1982 presented higher concentrations of TOS at the surface and at the deeper portions of the water column. ?Te month of January presented maximus values at depths of 4 and 8m (see Table X12) evidencing substantially higher concentrations of TDs ?than the months of February and March, 1982.

Tributary stations averaged 214 ng/t at La Plata River, 289 ng/t at Guadiana River and 267.5 mg/t at Cafias River (see Table xxI1). ?Te apparent disparities of TOS with conductivity relationships have ?already been noted.

Total Alkalinity

Total alkalinity measurements (see Table XIX) ranged between 192 g/t as CacO,. The profile of total alkalinity at the lake station I-r presented, in general, higher alkalinities in the upper strata where aerobic conditions prevail and pil values are higher. Lover alkalinities result belov the oxygen chenocline.

?Tributary stations averaged 130 mg/L as Caco, at La Plata River, 122 mg/f as Caco, at Guadiana River and 114 mg/L as Caco, at Cafes

3

River during this quarter (see Table xv).

---Page Break---

Nutrient Concentratiins

Ammonia-Nitrogen (ts-8

Water column avurage concuntrations of Nily-N ranged between

102 mg/L in January and .18 ng/L in March, 1982. The profile of

Mij-¥ maintained a pattern of increase with depth during this period

(Gan.-March, 1982) at 1-1 (see Table XVI). Anmonia-nitrogen is

generated by heterothrophic bacteria as the primary end product of

Gecomposition of organic matter, either directly from proteins or

from other nitrogenous compounds (Wetzel, 1975). High concentrations

of MH,-" in the hypolimnion may be the result of acctmulation under

?anoxic conditions in the bottom strata. Under aerobic conditions

An the trophogenic zone Ni-N is assimilated and metabolized by phytosynthetic algae and floating macrophytes.

?Tributary rivers averaged .06 mg/t at La Plata, .02 mg/L at Guadiana and .01 mg/L at Cafas (see Table XVII). As previously noted in the profile of Decenber, 1961 at InI (see First Quarterly Report) NO,-WO, was higher after high precipitation and watershed runoff, It appears likely that the maximum values observed in Yanvary resulted from December rainstorm events. Watershed input is evidenced during this period by the higher concentrations measured ?at tributary stations (see Table XIX) vhere Wo,-NO, concentrations averaged .76 mg/l at La Plata River, 1.16 g/L at Guadiana River and 1.21 mg/l at Cafas River.

?The profiie of NO,-NO, vs. depth evidences, in general, lover

concentrations in the trophogenic zone and higher concentrations



---Page Break---

Aluctuating between iepths fron 8-20 m. Ay in the case of anmonia nitrogen profiles in icate assimilation by photosynthetic organises

An the upper layer of the water colin

Total _Kjeldan1_ nitrogen

The water column average of TH for the quarter (Jan.-Mar., 1962)

was 61 mg/t (range .46-.72 g/t) at I-I (see Table XX). The vertical

Aistribution of mc

yeentrations indicate higher values in the deeper

portions of the water column (16-20 =). The origin of these higher

concentrations near the bottom is possibly associated to the sedimen-

tation and accumulation of organic compounds. The lover concentrations

of Ma at tributary rivers (see Table XXI) tend to support the hypothesis

that inorganic sources of nitrogen such as N¥,-NW and NO,-NO, are being

incorporated by autochthonous lake organisms which contribute to the

organic matter load of the sediments after death.

Soluble Reactive Phosphorus

?The water column average of SRP concentrations at I-I was .11 mg/L.

SRP is the most available source of phosphorus for phytoplankton and aquatic vegetation in their metabolic processes. Lover concentrations

of SRP shove the chenocline (<ta) indicate rapid epilinnetic removal by

?Algal and floating vascular plants there, Table XX1T presents the water

coluan profiles of SRP at nz. All tributary stations evidenced higher

concentrations of SRP indicating their inportance in delivering nutrients

to the lake (see Table XxI23).

?2%

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Total Phosphorus

?Total phosphoru: concentrations presented a water coluan average

Of .22mg/1 at Int (sce Table XAV). This concentration characterizes

the lake as hypereutrophic according to EPA 440/5-80-11 document.

As previously established, the main vehicle of phosphorus loading

appears to bo La Plata River with average concentrations of .21 mg/t,

00 Table XVI. Guadiana River evidenced higher concentrations of

?total phosphorus (X= .33 mg/t) but the discharge of this tributary

Feprosents less than 58 of the total tributary discharge into the lake.

2 spatial variability analysis of the distribution of total phosphorus

(at surface and 4m) performed during the first quarter (Oct.-pec., 1981)

Andicated that a gradient of higher surface concentrations is found

from La Plata River to InI (see 1st Quarterly Report).

BIOLOGICAL PARAMETERS

QMorophyli-a + Te profil

11 are presented in Table XXVI, Water column concentrations averaged

of chiorophyli-.

concentrations at

7.77 mg/n? with surface concentrations representing a 498 of the

?total chlorophyli-a crop. In general, the profiles show a marked

@ecline of chlorophyll-a below depths of 4 meters. This appears to

bbe associated with higher phytoplankton crops in the surface layers

land the presence of undecomposed fragments of macrophytes. According

?to EPA-440/5-79-015 (1979) such surface concentrations of chiorophylldefine La Plata Lake as an eutrophic system.

A spatial variability study of surface chiorophy21-

?trations has shown that higher concentrations are found at the lake

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Stations ond dimin:sh toward the La Plata arm ot tho lake (see

Quarterly Report). Tributary stations were conspicuously lower

than the Jake station (nz) in chlorophyll during et

period (see

Table WVIt) confirming the endogenous origin of the lake values.

otal Colitoras

Table XAVIIE presents the profile of total coliform concen trations at L-1. The average water column concentration was 598 MPN/ 100 mis (range 265 1118 MPN/100 mts). Standard regulations of water qwality (G98, 1973) recomend an upper Limit of 10,000 MPN/100 mts for superficial waters of Puerto Rico.

?Tributary rivers (see Table XIX) evidenced higher concentrations than lake waters, however, none of the resulting concentrations sur ass superficial water standards during this period (Jan.-Mar., 1962).

Focal coliforms

Fecal coliforms averaged 20 MPN/100 mis at I-1 (range 50-396 MPN/ 300 mis), see Table x00, Tributary rivers presented higher concen trations of fecal coliforms (see Table 1X1). Standard regulations of water quality (£98, 1973) recommend an upper Limit of 2,000 mpu/ 100 mts for superficial waters of Puerto Rico. Guadiana River ?evidenced concentrations above the limit recomended during the month of February, 1982.

1 Streptococcus

Table XOOUT presente the concentrations of fecal streptococcus

at In, Water column averages ranged between 6-74 MPN/100 mis.

Evidence of fecal streptococcus was found on all sampling dates.

29.

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Concentrations wer higher o¢ tributary stations (sce Table xxX711) with means of 48 8/100 mis at La Plata River, 188 MPH/100 mis at Guadiana River and 262 MPN/100 mts at Cahas River.

weavy Mera

The concentrations of Cu, C4, Pb, and 2n in yig/E at the lake station L-r and the main tributaries are presented in Tables XXXIV 420 XXXV. Among the concentrations of heavy metals examined the only fone which was found to exceed surface water quality standards was Fine, The average water column concentration of Zn was 120 i9/t. at the lake station I-r. The Limit reccomended by QB regulations of Water quality (EpB, 1976) for eurface waters in 50 19/2.

Macrophyte Cover:

?The dominant macrophyte species present in Lake La Plata is the water hyacinth Eichhornia crassipes. An estimated percentage coverage of 2808 of the total Lake surface area is impacted by water hyacinths. The eriteria in evaluating the area impacted within 2x secchi disk

@epth vas not considered in view of the fact that E. crassipes is

4 floating macrophyte species which invades lake surface waters and

is not Limited by Light penetration.

Water hyacinths

xy induce or enhance the proper conditions for

Asssolved oxygen deficiencies in the water column by Limiting light

Penetration and subsequent photosynthesis inhibition. They also

represent @ recreational problen by obstructing navigation and fishing,

an SUlustration of hyacinth cover in ta Plata Lake is presented in

Figure 11.

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gure 12, Wate hyacinth coverage at J. Plata Lake pote represent hyacinth

?coverage.

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cusnry

Four sampling excursions to the study area were performed during

?the second quarter (January-March, 1982) of the diagnostic-restoration/

feasibility study of La Plata Lake. These included three regular

(monthly) sampling activities at monitoring (fixed) stations in the Lake

and tributary rivers and one pccial investigation designed to evaluate

Our present monitoring lake station (II) as representative of the water

guality condition at the dam site where the intakes for public water

supplies are located.

After completion of six months of investigations, the most important

findings may be sumarized as follows:

a. Temperature profiles decrease gradually from the surface evidencing

@ weak stratification in the absence of a well defined thermocline.

?me dissolved oxygen profile Ss clinograde with a strong cheno-

cline Muctuating between 2-5 meters.

?Total alkalinity, pH and specific conductance decrease with depth

?at the lake station.

?The concentrations of total dissolved solids vary independently

from specific conductance distribution.

© Wvailable micronutrients such as SRP, M,-" and NOj-NO, evidence

higher concentrations in the hypolimnion reflecting epilinnetic-renoval

bby photosynthetic organisms and accumulation under the anoxic strata of

the vater column.

£. Loading of nutrients, 755, bacteriological contamination and

Aissolved oxygen are largely contributed by tributary inputs.

o32-

---Page Break---

9+ Chlorophy1i, phytoplantton abundance and water hyacinths coverage increase dovnstream from La Plata ar of the lake.

h, During the first quarter, the lake and tributaries showed evidence of bacteriological contanination?concentrations above the recomended surface water standards. During the second quarter of the study only the Guadiana River station (W-2) vas above the limits.

i. Among the trace metal concentrations studied (ig, Cu, Ca, Pb,

Cr and Zn), zinc was the only one that exceaded surface water standards for PLR,

4+ The measured concentrations of total phosphorus and chlorophyll-a continue to be high and consistent with the classification of La Plata Take as an eutrophied system.

k, Special close time interval sampling indicates that the standard lake station L- ie

ntially the sane (within a normal acceptable

Sampling error) as a station adjacent to the dam and may therefore fairly

repres

wt the main body of the lake,

1, Surface flow measurements and watershed drainage area indicate

that La Plate River accounts for more than 90 of the total water that.

enters La Plata Reservoir.

In view of these findings, several hypotheses have been postulated

in order to understand some of the basic structural and functional

features of the lake.

Hypotheses to be further examined:

1. The Lake is oligomictic (mixing occurs xarely and probably

aperiodically during store, high rain and runoff conditions or under strong wind circumstances) .

a.

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2. The thermal stratification of the water colunn within any strong thermocline is of low stability.

3. The morphonctric features of the lake, especially its high volume te surface area ratio tend to isolate the hypolinnion from mixing forces such as normal winds and river discharge.

4. Dissolved oxygen consumed in the hypolimnion is in equilibrium with that entering from the epilimnion.

5. Low dissolved oxygen prevents the establishment and maintenance of producers in hypolimnion.

6. Higher concentrations of TH and total phosphorus in the deeper portions of the water colum result from accumulation of organic matter which originates at the surface of the lake such as water hyacinths fragonts and phytoplankton an@ zooplankton sedimentation.

?The special investigations directed to test hypotheses 4 and 5 will ?be focused on primary productivity experiments at various epilimnetic

Gepths, BOD analyses and 24 hr measurements of pi, 0,, temperature,

conductance and total alkalinity. Hypotheses 1, 2 and 3 will have to be

approached by sampling during or immediately after rainstorm events capable of changing the stratified structure of the water column. Testing of dypothesis 6 will be attempted by analyzing TOC samples in a vertical

Profil



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