CEER-M-166

CHANGES 1N DIEL PRIMARY PRODUCTION IN

JOYUDA LAGOON ON QULY 7 AND 8, 1983

by

Roberto D. Rice

Gary Owen,

Supervisor

August 1983

CENTER FOR ENERGY AND ENVIRONMENT RESEARCH

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CANIGES. £8 DIEL PREMAEY PRODUCTION TN

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?esearch was conducted at the Center for Energy and

?Sronment Research under the auspices of

Tak Ridge Associated Universities

Somer Student Participation Program

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ACKTONLED EEN

te indebted to sve Marine Scology Division of the Center for

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nt Pesearch for sroviding the frien!y and helpful

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tine, support, guidanco and understanding without which

wid not have been completed,

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assTiacr

On 7 and 8 July 1983, a 28 hr study was conducted in Joyuda

n. Dissolved oxygen, temperature and salinity measurements were

telen at two he intervals fron sever regions within the lagoon and fron

station within the channel, connecting the lagoon to the Guanajibo Channel. Uniike studies conducted in Novenber and February, Joyuda Lagoon wos found to have 2 north-south gradient for the study parameters.

Prinary production

hin the lagoon water colunn appears sufficient to

et planktonic respiratory and carbon requirenents. The volune of

between the Tagoon and the Suanajibo Channel vas

?oesvingtely equal, but the tota? volune of water flowing into the

tajcon was insiontfieant in relation to 4s volume. Over an extended

veriod of tine Joyuda Legoon may enrich the surrounding coastal waters.

P>ankton grazing appears to be significant in the lagoon.

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LIST OF Figures

Study rea $e Localization

1/86 8egfons Ia Taye Lagoon with Bathyetry

"ters. .

Svee Grsyen for Region 1 of Joyuda

sao During 7 and B duly 1983... ee ee

Region 2 of Joyuda

Dissulved Oxygen for Station 3 in Joyuda

ring 7 and 8 Juty 1983,

re Bisgolucd Ourges, for Region # of Joyude

n during Pand 2 defy 193.0...

us Svssolved Oxzgen for Region (5-6)

2 Lagoon During 7 and 6 July 1983... .... 6.

Say.

Changes_fn Dissolved Oxygen for Region 7 of Joyuda

Lagoon Suring 7 and 8 July 1983... 2... we

changes in Dissolved Oxygen for Region 8 of Joyude

?ase0e During 7 ane 8 July 1983,

ltr Uissolved Dxygen tor Joyude Lagoon During 7 and &

why 1983. 7

Yean Mater Tenperature for Jeyuda Lagoon Ouring 7 and

B duly 1982,

an Percent Cloud Cover for dayuds Lagton During 7 and

B ovly 1983. Seen tenes

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?cotane Mean Surface Arcesy Depths, and Yolures for

Toysda Lagean, . . See

finova Table for Dissolved Oxygen, Temperature, and

ein for ihe Seven ogons, nin deyudn Lagoon

for the Event of 7 and 2 July 1983

SYK Mui Fiple Comparison Test for Dissolved Oxygens

Taoersture, and Salinity finong Regions in Jovuda

agoon During the Cvent of 7 and @ July 1983...

ple Conparison Test for Dissolved Oxygen,

Tenpereture, Salinity, Wind Velocity and Percent

?oud Cover fans Different Times for Jayuda tgoon

wring the Event of 7 and & July 1973... .

Production, Respiration, Gross Production, and

ration Ratio for the Seven Re

Lagoon for the Event of 7 and

Regional Wind Velocity end Direction for Joyuda Lagoon

During the Event of 7 and 8 July 1983... tees

fnova Table for Wind Velocity for the Seven Regions

hen doyuds tageon for the'Event of 7 and 8 duly

Bnova Table for Percent Cloud Cover for the Seven

Regfons within Jayuda Lagoon for the Event of 7 and

Bouly 1983. eee eee

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2

6

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TR0cueTION

Soyuds Lagoon is currently the subject of a series of studies

which are attersting te determine tw 9 tropical Tagaon ecosysten

urctions. AS one part in this cffort, this study examines the Tevel

of planktonic pr?sary production in Joyuda Lagoon during one event in

atively wot season of July. In particular, it attempts to

.

ne 1) whether this production #8 subsidized from the surrounding

fenvivonmerts 2) the significance and effect of coastal exchange and

nat ere the spatial and temporal patterns of production in the lasoon,

Inet are the underlying a

S controlling these patterns.

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DESCRIPTION OF STUDY AREA

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ida

n is located in an area classified as a Subtropical

id Forest (Gti, 1972-79). It + found cn the west coast of Puerto

soxtrately Sales south of Mayaguez at Lat. 18°09°N, Long.

871% (Pesante. 1978) (Figure I), It is approximately 1.6 km Tong,

9.8 kn wide, with a surfa

ce of 121 hectares, The nean cepth

Sb uy wth 2 uaxinun depth of approximately 4m (Garcia, 1981)

(icura 11), A 15 to 20 meter band of mangroves (DRH, 1978-79) borders

the lesoon (Pesante, 1978); the red mangrove Rhizophora mangle.

nates but black mangroves, fvicenia niti¢e, and white mangroves,

are alse found (Garcia, 1981).

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BATERIALS AND FTHODS

During the 28 hr event on 7 and 8 duly 1983, measurenonts of selected

esyfrcanental parameters. 931

taten every two hours from the 6 regions

?ons (9 and 3) Indicated in Figure II, The regions and stations

were chosen be

use of data collected in earlier studies at these locations.

1 rogion and station occupations, messurenents of dissolved

Asien (D.0.), temperature, salinity, end a sounding with a secchi disk

A tevoerature conpenstated 9.0. meter was used for taking D.0.

LS. Mode} 87, eccureey of 40.1 ppn). A thernistor

1.S.1, Model 57, accuracy of +0.7°C) was used for temperature measurements

and an induction satinoneter (V.5.1, Mode! 33, accuracy of 49.7 pot)

used for measuring salinity. where the water colunn was greater

thar 0.5 m tno replicate measurerents for these parameters were taken

at 0.25 m from the surface and at 0.25 m from the bottom. If the water

column was less than or equal to 0.5 m (only at station 0), measurements

vere only taken 0.25 m from the surface.

Wind velocity (measured with @ hand-held Dwyer Wind Meter) and wind

ion (detersin

using a Saura H8-650 Compass) measurenents were taken

uphout the event, except within the channel, station 0, where the

rangroves Timit the ability to take accurate measurements. Secchi disk

?ings were taken between the hours of 0600 and 1800; cloud cover for

the entire ?agoon was also estimated during daylight hours.

can Flow within the entrance channel, station 0, was determined

From Five meesurements across the channel (with . Kahn O0SHA200 Flow Meter

---Page Break---

302 conticence of 0.17

wrey 10.027) taken at 0.? depth for 60 seconds.

Mt the deepest spot in the channel, measurenents were also taken at 0.2

doth and 0.8 depth so that average discharge could be better calculated

(Lonstey, et. al., 1975). Three cenplete ebbs and one flood cross

sectional channel flow profile wire determined during the course of the

study. If @ corplete flow was not taken during the cycle then a spot

Frow check wos taken 2t 0.6 depth ir the deepest area. In this case, a

woininum of two 60 seconé replicate sarples were determined during the cycle.

ovophyl1 samples were taken during eight cycles at station 3. A

vertical Siskin sampling bottle (Modal 1010-1

-2 to 40L), with its mic

designated as the sampler's depth in the water, was used to collect

thy nater sanples from the middle of the water column. Between two and

Four 133

semoles were collected curing each cycle. One ml of MoCO3

ves added to the samples after filtering. After filtering, the glass micro-

fiber GF/C filters (ihatnan 4.25 cm) were stored in aluminum foil wrapped

bottles and placed in a cooler with an iee-brine solution until they coutd

be placed in a freezer (maximum tine was 8 hours later) (Standard Methods,

1978)

ratory Proc

Chlorophyl? concentrations in the samples were determined by the

Tuovonetric method after a 24 hr extraction with acetone (Standard Methods

1975)

Statist

Station, tine, depth, and the specific interaction effects for these

Davzveters wore analyzed for using analyses of varfance techniques. here

there

indications of non-normal eistributtos

or heterogeneous variane

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4 Sg Uransformetion ws made on the data, hen spy

Siffivences were observed SUK ?esLing was used to determine their

se-citie locations. Explanation of those statistical tests are presented

Sorat ané Roth (1969)

Net production was éeteratned hy counting squares on the regional

wroohy of positive (non-transforeed) changes 1m D.O. values versus

ures T1I-IK), and then ruTtiplying this value by the mean

?oth for the region, Respiration was calculated using two times the

nonative changes, to account for respiration during times of net production

Sress production is the sum of the net production and respiration. The

v/vespivetion ratio was calculated by dividing gross production

by respiration,

Corrections in production and respiration for the gas exchange fron Soyude Lagoon to the atmosphere are small, 0.2% to 1.02, relative to she observed onygen changes (TiNy, persona? conmunscation). Due to the sual] size of this correction factor, and because the correction factor is not absolute, this correction was not made for the data.

The regional surface areas and their mean depths were determined

by cutting the areas out from Figure II and passing them on a Mettler

nce, Type H6T dig (precision of #9.00005 g). Regional volumes

wore determined from this information (Table 1).

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TABLE 1. Regional Heon Surface Areas, Depths, and Yolunes for doyuda

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west0N SURFACE AREA

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RESULTS

Previous to the completion of this study a heavy storm occurred

within the survey region which

?oubtedly influenced the results

resented here.

Dissolved Oxygen - The mean content of 0.0. in the lagoon was

5.09 ppm mean D.0. saturation was 6.6 opm (89% saturation). Table

resents the significance of the different sampling parameters

The lagoon was found to have a north-south gradient in oxygen with regions 7 and 8; station 3; regions 4 and (5-6); and regions 1 and 2 each statistically different (Table III). The magnitude of the mean non-transformed 0.0. differences between these groupings were 1.00 : 2.10 11d, respectively.

Diel 0.0. concentration was found to be lowest between 0600 and 1000, increasing significantly at 1200, and reaching its peak at 1400.

It then declined uniformly from 1600 to 0400. July 8th's 0600 and 0800 values wrapped around July 7th's values (Figure X and Table IV). The Towest mean 0.0. was 4.98 ppm and the highest mean D.0. was 6.52 ppm,

a 23.6% difference.

Mean 0.0. was significantly hicher, by 2%, at 0.25 m from the surface,

5.96 ppm, than at 0.25 m from the bottom, 5.84 ppm.

There were significant differences in regional relative mean 0.0.

ratios during the event. At different depths there were significant

differences in 0.0. anong the regions and there were significant differences

?n mean 0.0. throughout the day with respect to depth. 0.0. also varied

Stonificantly within the different regions with respect to tine and depth.

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TABLE 111. Sitk Multiple Comparison Test for Dissolved Oxygen, Torperature,

?and Salinsty Anong Regions in dayuda Lagoon During the Event of

133

Region Region Region Region Region Region Region

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Tenperature ae

Salinity 4 1

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Production and Respiration ~ Table V presents information on net

Production, respiration, gross production, and the gross production to respiration (P/R) ratio for the difverent regions. The nean P/R ratio for the lagoon was 1.9 40.034 g/n?/day, Region 2 had the highest P/R value, 2.8 g/m?/éay, and region 8 had the lowest value, 1.3 g/n?/day. Figures TI1-IX show that there is a large oncunt of fluctuation from the general trends of net production and respiration.

Tenperatur

Table IT presents the significance of the different sampling parameters

The mean tenperature for the lagoon was 28.8 °C.

@ magnitude of the regional effects was minimal. Region (5-6) had

the lowest mean temperature value, 28.6 °C, and region 8 had the highest vetue, 28.9 °C. The mean temperature for the lagoon rose in the morning, peaking at noon with a value of 30.0 °C. As cloud cover and wind velocity increased in the afternoon the mean water temperature began its decline winch lasted throughout the afternoon and evening unt11 0200 where it leveled off to its low value of 28.0 %

?At 0800 tenperature began

?increasing again (Figure X1). Tables III and IV provide the regional

and time SNK groupings.

?The mean relationships of the tenperatures between regions changed

Significantly throughout the event. It also changed signtficantly

throughout the different regions with respect to depth, and with respect

to both time and depth.

Sal

?ty = The mean salinity for the lagoon was 26.5 ppt. Table

MI presents the significance of the different sampling paraneters. Despite

?the sign?ficant regional effects, the range between the regions was only

0.6 ppt, a 2.2% difference. Region 4 had the lowest salinity, 26.2 ppt,

n

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TABLE V. Net Production, Respiration, Gross Production, and Production/

Respiration Ratio for the Seven Regions Within Joyuds Lagoon

_for the Event of 7 and 8 July 1983

GION NET PRODUCTION RESPIRATION GROSS gooUCTION F/R

6 Op/ne/aay?_G/ne/day Gia /day

2.5 LT

2 5a 23 8.0 2.8

3 an 44 35. 1.9

4 3.0 4.0 7.0 1.8

(5-6) 2.4 2.9 5.3 18

7 2a a7 48 1.8

8 5 5.0 6.5 1.3

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and region 8 had the highest salinity, 26.8 ppt (Table 111). Salinity for the lagoon varied 15% with respect to time; if the lowest value, an unexplained anomaly, is excluded, it varies only 8.22. Salinity

sed during the day, reaching its peak value of 28.0 ppt at 2200

and thon declined unt#l denn (Figure XII and Table IV).

Relative salinities between recions changed significantly throughout

the event.

Chloroghy11 - The mean value for chlorophy! was 5.97 40.01 mg/n?;

there was no significant change in chlorophyl1 throughout the event.

Secchi Disk - There was no significant change in secchi disk readings

45 a function of time throughout the day. There was, however, @ significant

éiffarence in secchi visibility between regions 8, 7 and 4. Mean secchi

depth was 9.94 m. The differences in magnitude between the three regions.

00 ; 1,02 : 1.20, respectively.

5

~ Ebbs occurred at a11 times except during 1600, 1800, and

2000 sampling cycles when strong floods appeared, Due to great variance

Of unexplainable nature in the flow data, it is impossible to calculate

the precise Flow volumes. However, the total flood volume for the event.

appears to be equal to or higher than the total ebb volume. Despite this,

the maximum flood volune (150 m°to 330m) for a two hour period would be

between 2.6% and 5.7% of region 1 volume, 0.00012% to 0.00027% of the total

Vegoon's volume.

Hing Velocity and Direction - The nean wind velocity for al1 regions

im the Tegocn during the event was 4.2 m.p.h. (Table VI). Wind velocity

1d significa

ly throughout the event

it also differed significantly

for the different regions. (Table VII presents the significance of the

2

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TASLE VI. Regional Wind Velocity end Direction for Joyuda Lagoon

uring the Event of

EAN IND VELOCITY VERN WIND DIRECTION

?(MILES /HOUR) (IN DEGREES)

1 aa °0

2 4.3 16

3 48 9

4 47 in

(5-6) 49 123

7 5.2 335

8 2.4 149

8

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13.8 July 1983

?source ar MEAN SQUARE

Subcroups 7 14.3033"

Region 6 15.5412"

Tine 3 rsa

Begin x Tine 78 3.6421

Eeror °

*- a logarithmic transformation (Log, oN) was applied to the data

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different sampling peraeters). wind velocity increased throughout

the morning, peaking at 1200 with a wean velocity of 6.1 mp.h Af

i.

1600 the nean wind velocity declined rapidly developing into the lowest SMK grouping between 2000 to 9500 (Fri), which had a mean velocity of 0.77 m.p.h, (Table TY and Figure X131).

Wind direction in the southern part of the lagoon tended to be coming fron the east, while wind direction in the northern part came fron

the south-east (Table Vi).

wer - Cloud cover varied significantly throughout

the day, (Table VIII presents the significance of the different sampling

Dovaneters). The mean cloud cover during the periods of daylight was 382, During the early morning, percent cloud cover was lowest, with @ mean value of 8 212%. Between 1200 and 1800 percent cloud cover was

highest, @3 4172 (Figure XIV and Table IV).

ng Direction - Wind direction in the southern part of the lagoon

tended to be coming from the east, while wind direction in the northern

art came from the south-east (Table VI).

8

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TABLE VIIT. nova Table for Percent Cloud Cover for the Seven Regions,

fn Joynda Lagoon foe, the Fy 7 and & July 1983,

seunce MEAN SQUARE

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DISCUSSIONS AND CONCLUSIONS

The P/% ratios (Table V) show that the water column in all regions.
of Joyuda Lagoon produced more carbon than they use. Consequently,
it does not appar that the planitonic primary production needs a carbon
subsidy from the surrounding environment,

The volume of water flowing through the Guanajibo channel is
insignificant coupared to the volume of water in region 1. Consequently,
it would have no effect on the parameters measured in the lagoon decause
of the linited period of study. However, it fs of interest to note that
?their is a north-south gradient in mean 0.0. values with the regions
closest to the channel having the highest mean 0.0. values and those
furthest away from the channel having the lowest mean 0.0. values. It
is possible thet while the coastal exchange does not effect the lagoon
over a Timited period of study, it may effect it over an extended period

Since the lagoon produces more carbon than it uses, it may export sone of that carbon and thereby increase coastal productivity over an extended period of time, It fs also possible that the excess carbon Sinks oF 4s actively pulled down to the benthos by filter feeders for benthic consumption.

Increases in dissolved oxygen paralled increases in water tenperature and the non-significant trend observed in solar insulation.

Both temperature and saDinity distributions indicate that the Jagoon fs well mixed vertically. Since 0.0. 1s slightly, but. significantly hi

her at the surface, the benthos is probably using oxygen at a higher

than the rest of the water colum. The increased oxygen denand ts

---Page Break---

probably being used to deconpose the rich organic sediments (which were Frequently noticed on the anchor when it was raised).

The significant variation in relative 9.0. values within the water colunn during the study probably reflect temporal variation in production and respiration.

Since 0.0. experienced significant changes in productivity and standing stock, it would be exoected that chlorophyll, another indicator OF productivity would also experience these changes. Since it did not, ?the plankton are probably being grazed upon or they are settling to the

benthos

The ¢i#ferent mean regional values in wind velocity and direction and the changes in these factors throughout the event are probably responsible for the minimal change in spatial temperature, and the changes in the regional x time tenperature parameter. The regional x depth Gifferences in temperature may be caused by a circulation pattern which ray change according to wind direction and velocity.

?The rise in tenperature from 0600 to 1200 1s probably due to solar insolation. The high percent of cloud cover and the increased wind velocity 15 probably responsible for the decline in tenperature in early

afternoons nightfall causes this trend to continue unti? dawn.

The lack of finding a stratified lagoon with respect to tenperature or salinity indicates that the lagoon is well mixed vertically. This is not surprising since the lagoon was choppy in Tate morning and then during the afternoon,

The regional changes in salinity may be due to the regions being

effected by differences in solar insulation, which would effect the rates

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of evaporation. An additional factor could be that the volunes of

fresh water intrssion may vary from region to region. The increase in

salinity during the day is attributed to increased evaporation from solar insulation and increased wing velocity. The significant change ?in the regional x tine parameter is believed to be caused by the changes in wind velocfty and direction during the event

Using two tines secchi disk visibiDity as an absolutely Tiniting
factor for production (Parsons and Takahashi, 1973), light penetration
vas only a Timiting factor in the deepest holes.

Athou

h the secchi disk did not detect any difference in Tight
Snvensity curing the day, data from percent of cloud cover, and tenperature

woud indicate that there was a trend toward hai

0 Tight intensity
Increase sn the norming, peak in early afternoon, and then decTine untst
dawn, The Secchi disk probably failed to notice this difference because
It is not 2 very precise instrinent

In comparison to the diurnal events of Owen on 24 Novenber 1982
and 28 February 1983, this event noticed a different grouping of reofons
with resoect to the three main perimeters. Where as this event tended
to rou reatons 1 and 2: station 3 and regions 4 and (5-6); ond reoions
7 and 8, Owen's studies tended to croup regions 1,8, and 7: 3 and 63 and

2 and 55 with repion 8 overlapping the two later groups. The difference between this arouping may be due to eifference in wind direction and velocity. or the coastal exchange having a different effect on the Tag00n uring those relative dry seasons, IL 1s of interest to note that during ONT three events repions 7 and & had the lowest 9.0. values, and diurnal

temperature and 0.0. fluctuations were consistently noticed.

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