BRINE SHRIMP POPULATIONS, PHYTOPLANKTON, AND MODELING FOR MANAGEMENT (1994 – present)

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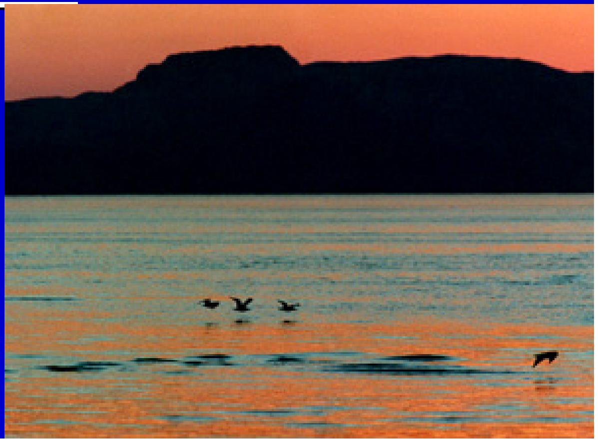
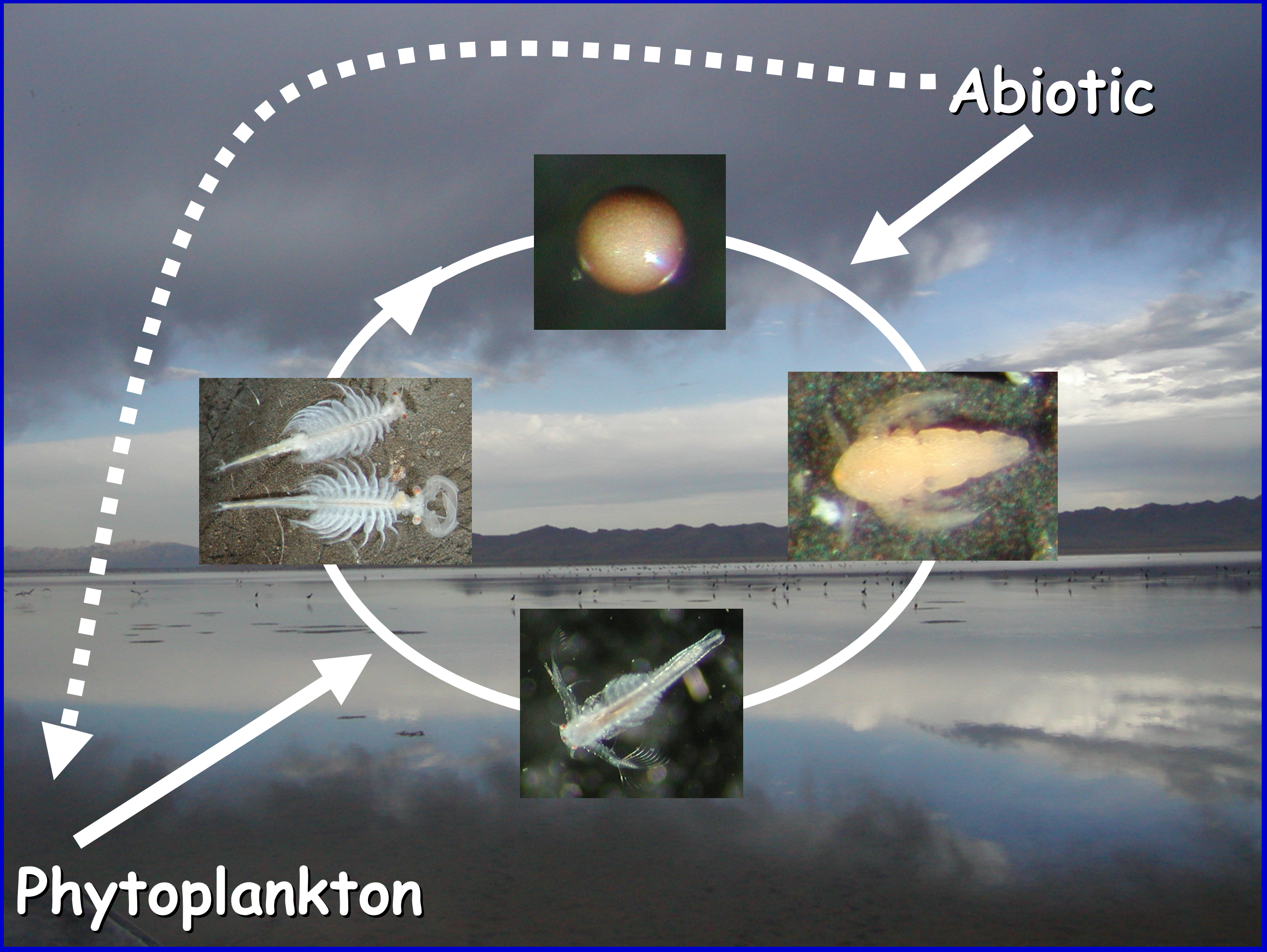
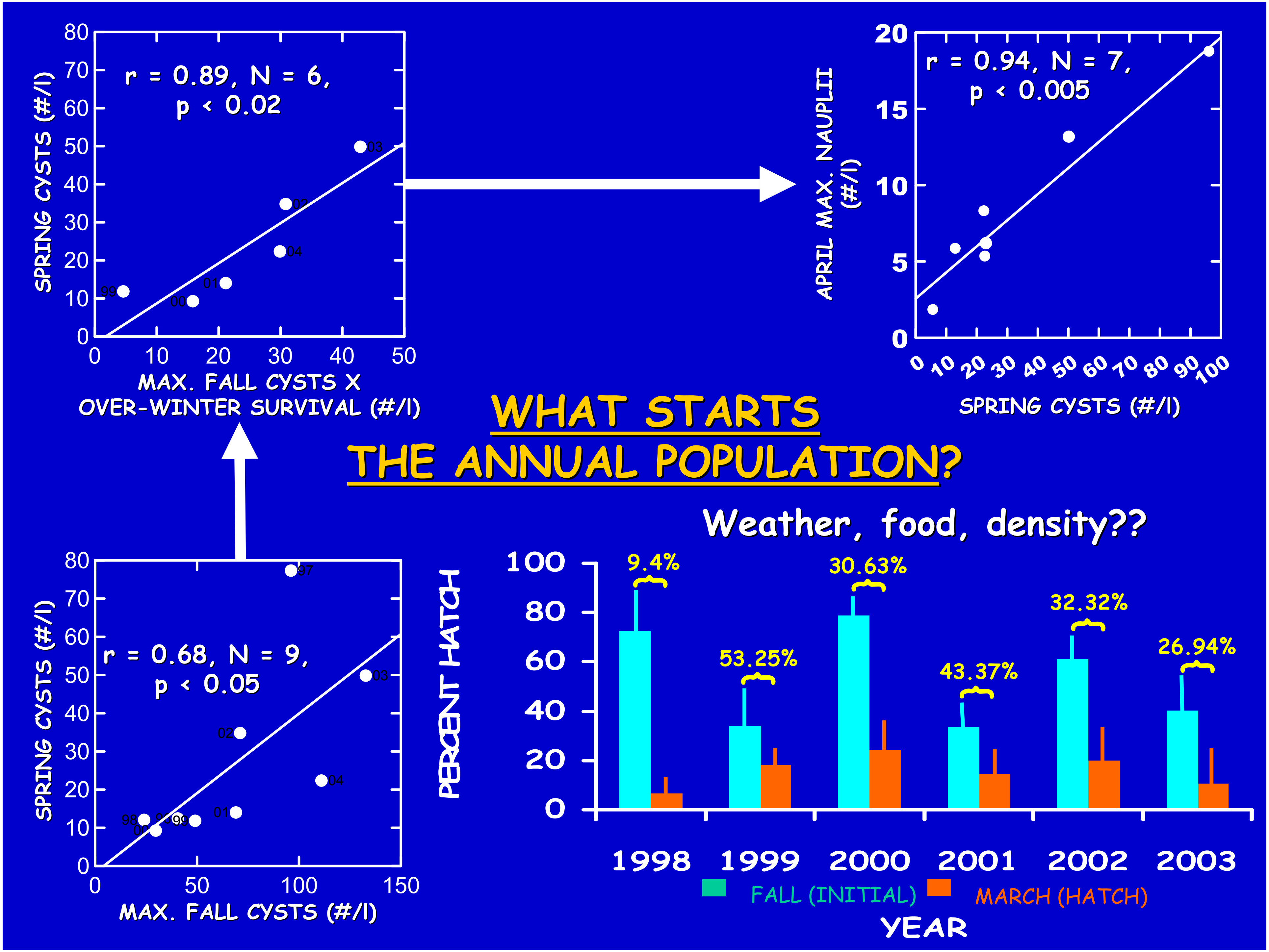
WORK OF
GSL ECOSYSTEM PROJECT
UDWR



WHAT CAUSES ANNUAL VARIATION IN SHRIMP SURVIVAL, REPRODUCTION AND NUMBERS?

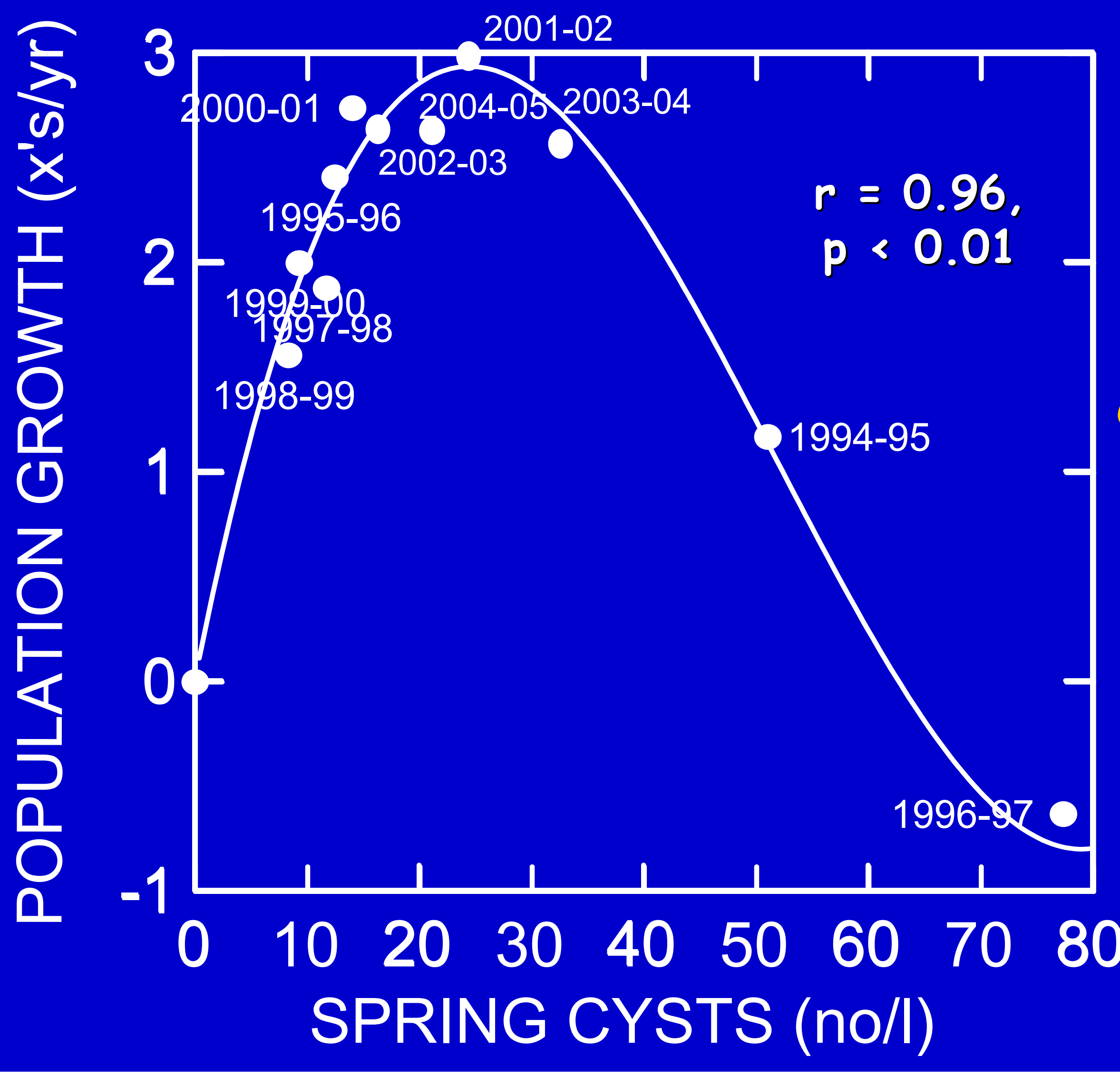
Critical for managing a harvested resource.




WHAT STARTS
THE ANNUAL POPULATION?
Weather, food, density??
r = 0.89, N = 6,
p < 0.02
SPRING CYSTS (#/l)
MAX. FALL CYSTS X
OVER-WINTER SURVIVAL (#/l)
r = 0.94, N = 7,
p < 0.005
APRIL MAX. NAUPLII
(#/l)
SPRING CYSTS (#/l)
r = 0.68, N = 9,
p < 0.05
SPRING CYSTS (#/l)
MAX. FALL CYSTS (#/l)
PERCENT HATCH
9.4%
53.25%
30.63%
43.37%
32.32%
26.94%
1998
1999
2000
2001
2002
2003
FALL (INITIAL)
MARCH (HATCH)
YEAR

DENSITY DEPENDENCE (intraspecific competition) FROM THE SPRING HATCHLINGS ON …

basis for annual management of harvest

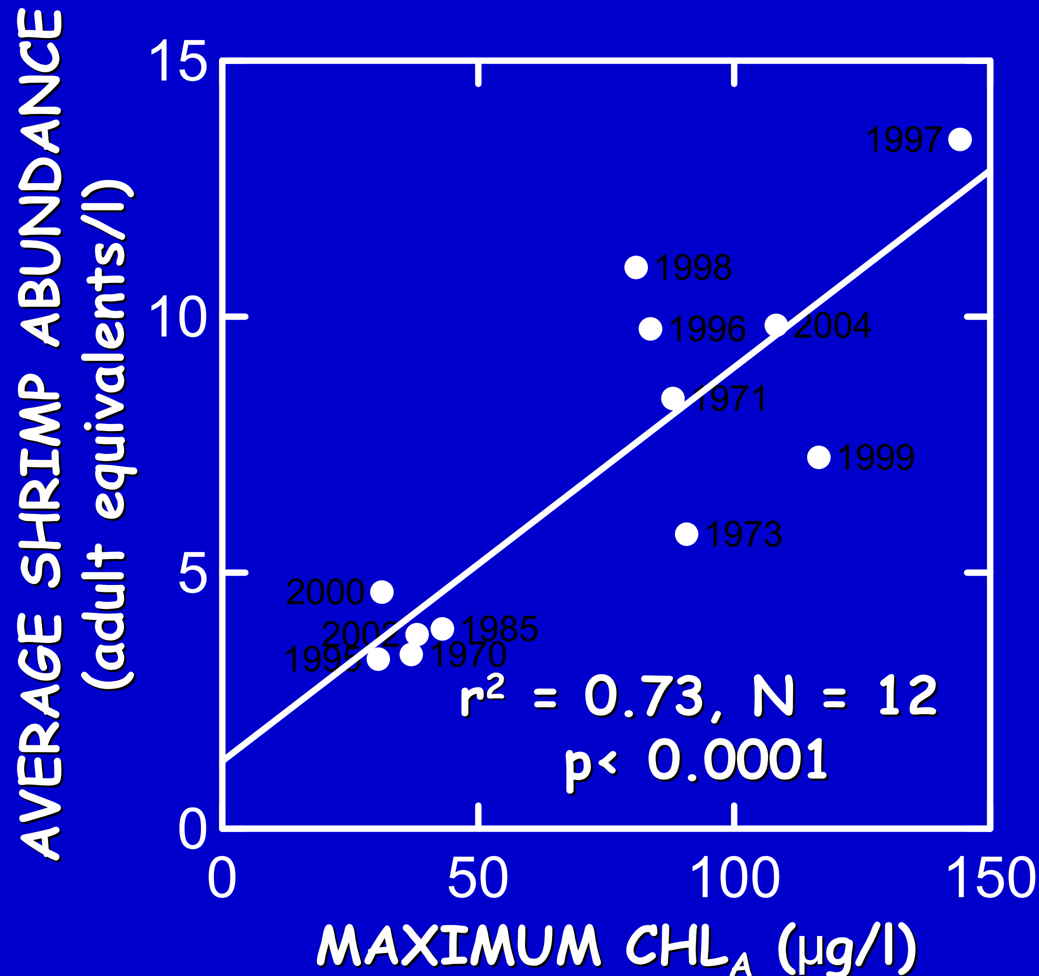


Computer model provides the same relationship! (r = 0.98)

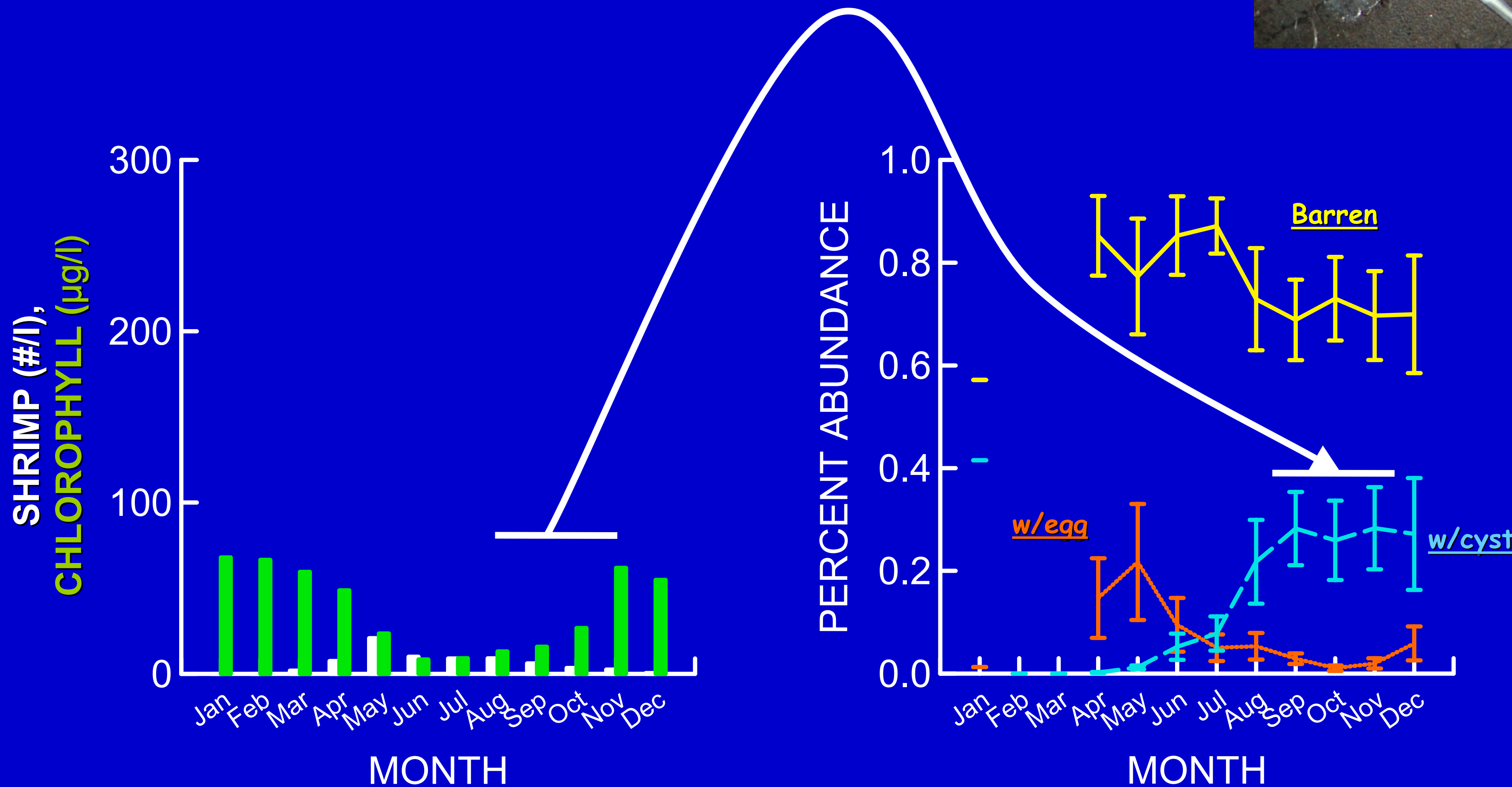
SHRIMP AND FOOD RESOURCES

(part I: between years)

Annual shrimp abundance increases with phytoplankton production



SHRIMP AND FOOD RESOURCES
(part II: within year)



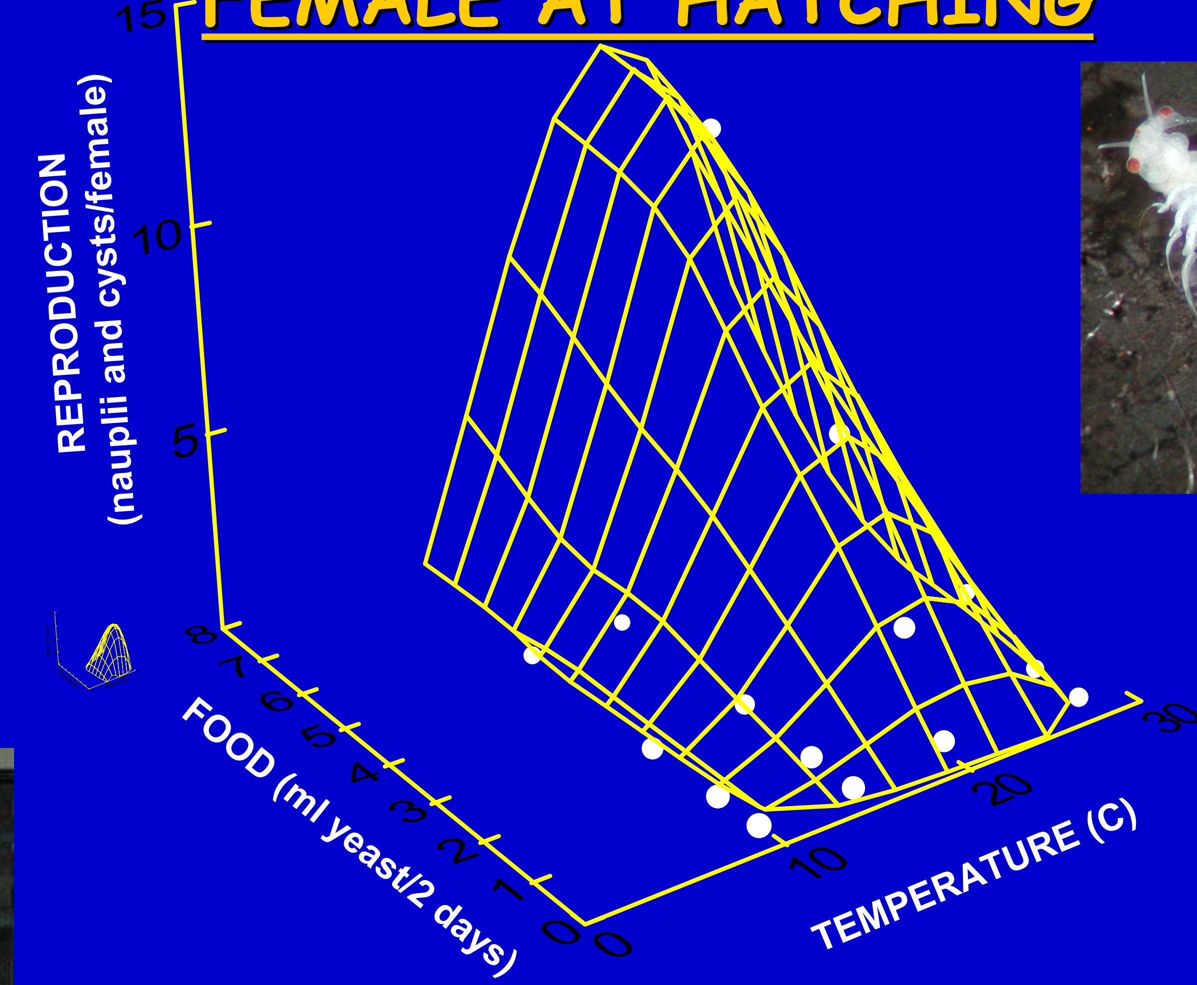
Within year—

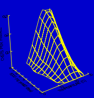
Shrimp decrease Chl_A ($F = 16.90$; $df = 1,69$; $p < 0.0001$)

Year ($F = 2.63$; $df = 10,69$; $p < 0.009$)

Cyst production dominates after food deprivation in lab ($p < 0.03$, $df = 2, 540$), and at low/high temperatures ($p < 0.0001$, $df = 3, 540$).

EXPECTED REPRODUCTIVE OUTPUT OF A FEMALE AT HATCHING





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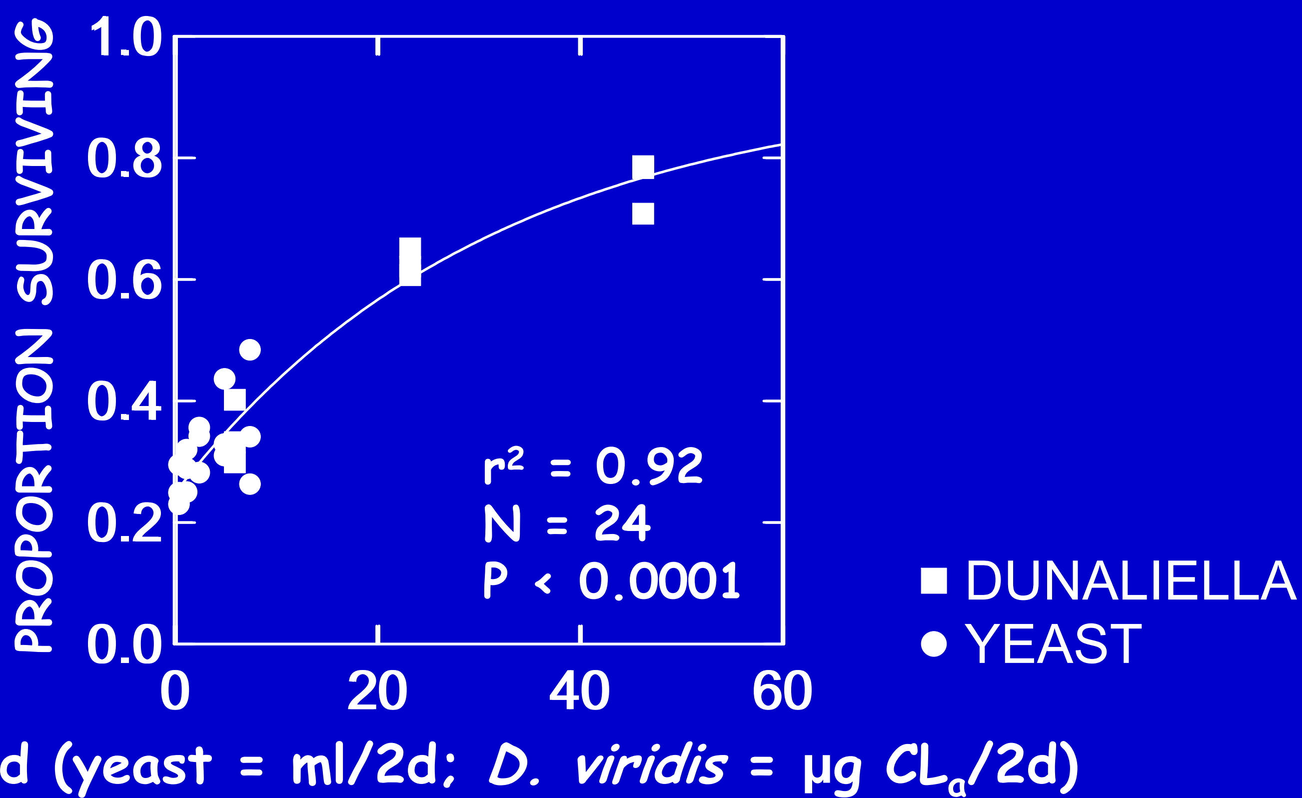
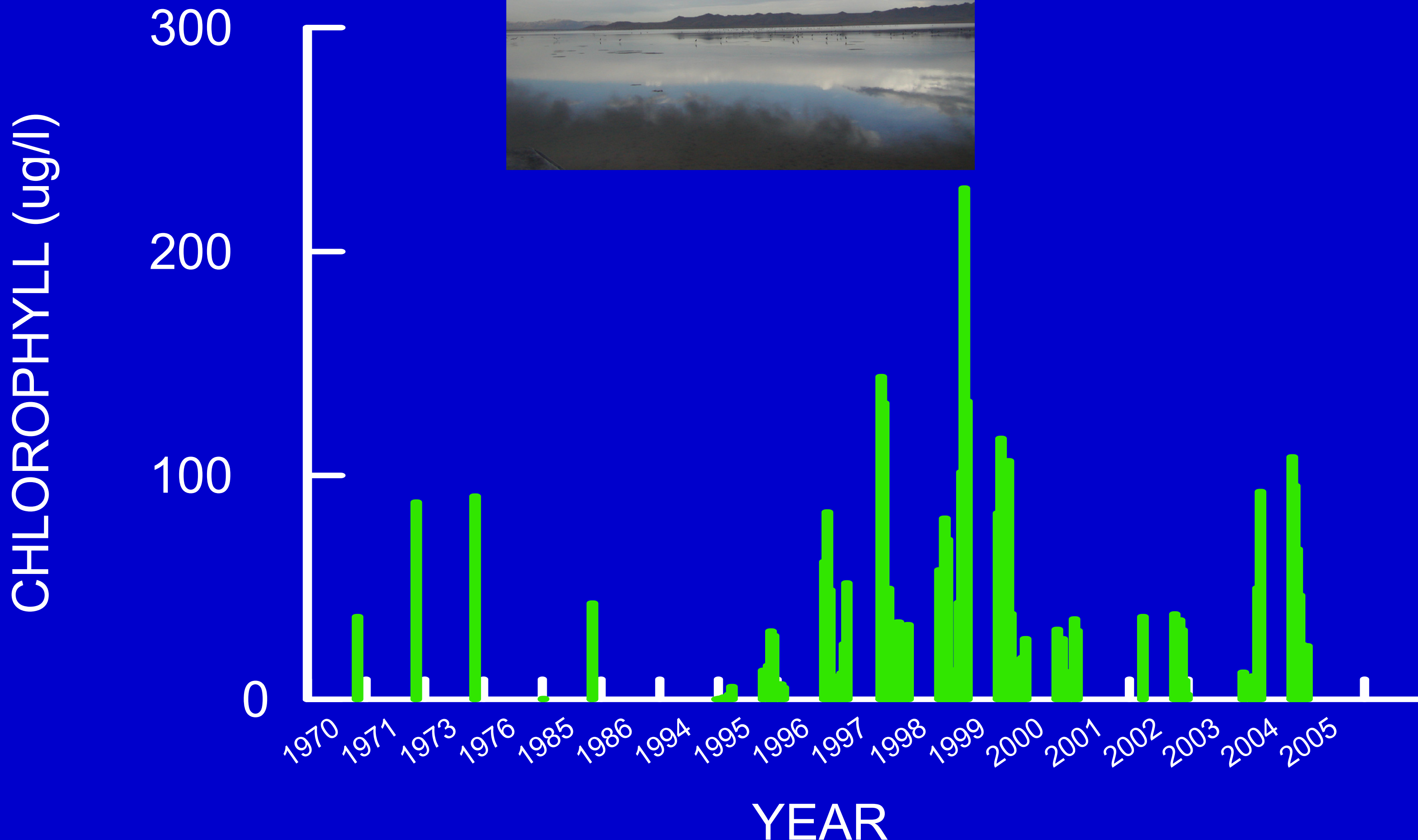
ADULT SURVIVAL ON YEAST VS. DUNALIELLA

calibration of survival, growth and reproductive measures using yeast



ANNUAL VARIABILITY IN PHYTOPLANKTON ABUNDANCE (CHL$_A$)



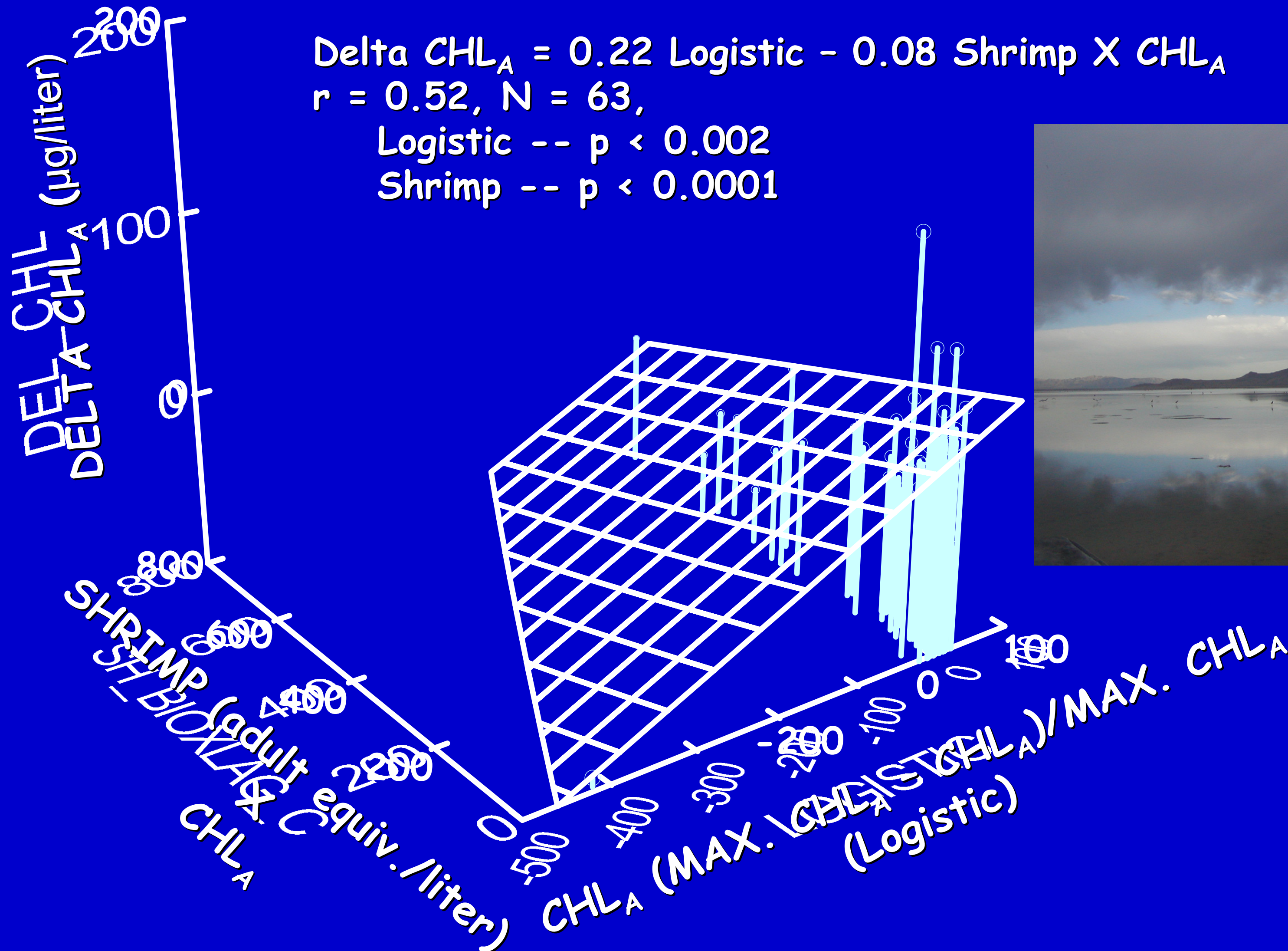
PHYTOPLANKTON ABUNDANCE DEPENDS ON SHRIMP AND THE OVERWINTER MAXIMUM ABUNDANCE

Delta CHL_A = 0.22 Logistic – 0.08 Shrimp X CHL_A

r = 0.52, N = 63,

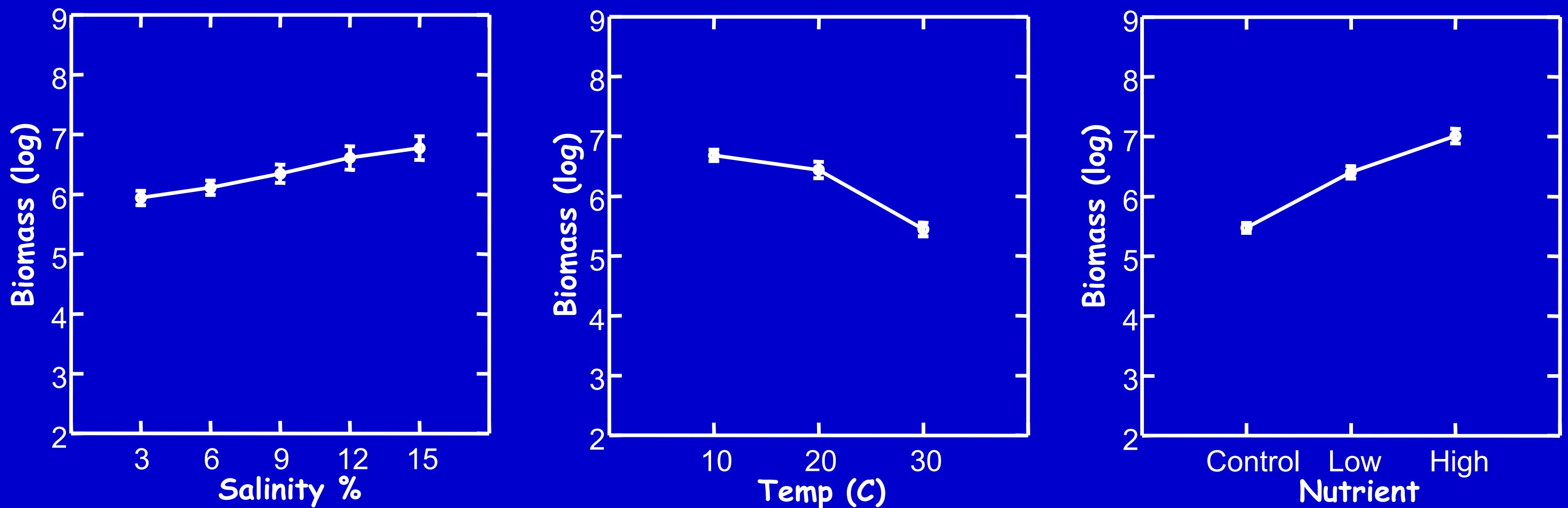
Logistic -- $p < 0.002$

Shrimp -- $p < 0.0001$



FOOD (PHYTOPLANKTON) RESPONDS TO MORE THAN BRINE SHRIMP

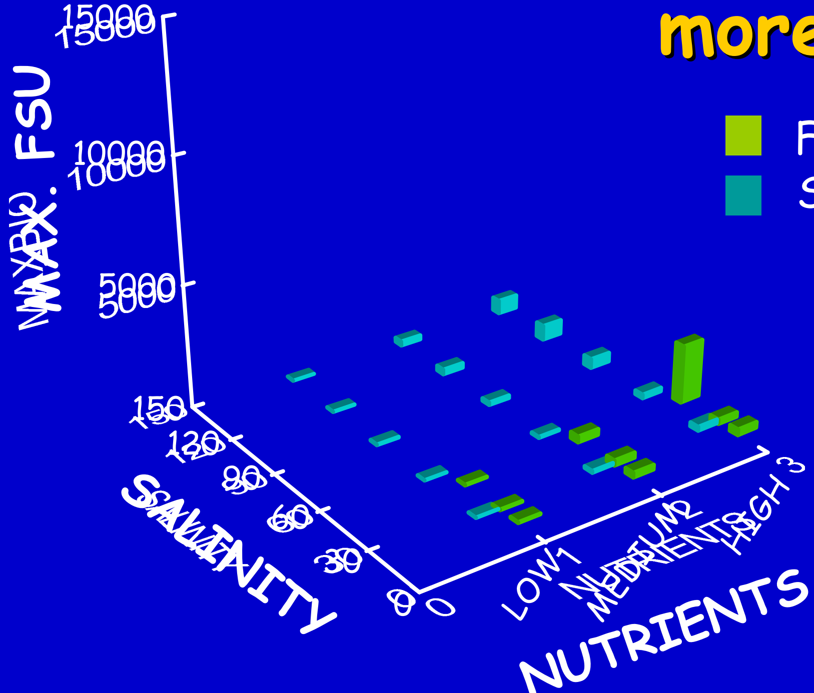
LAB (ANOVA) -- $r = 0.97$, $N = 160$
Salinity: $p < 0.0001$
Temperature: $p < 0.0001$
Nutrients: $p < 0.0001$



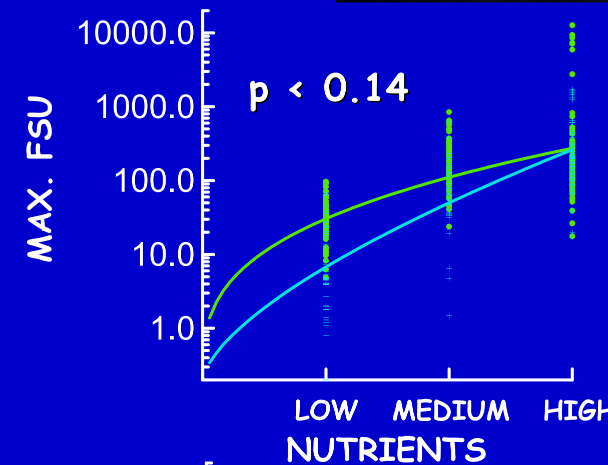
FIELD (residuals of Chl_A after shrimp abundance – Regression) -- $r = 0.43$, $N = 80$
Salinity: negative -- $p < 0.017$? Increased salinity means lower runoff and lower nutrients
Temperature: negative -- $p < 0.0001$

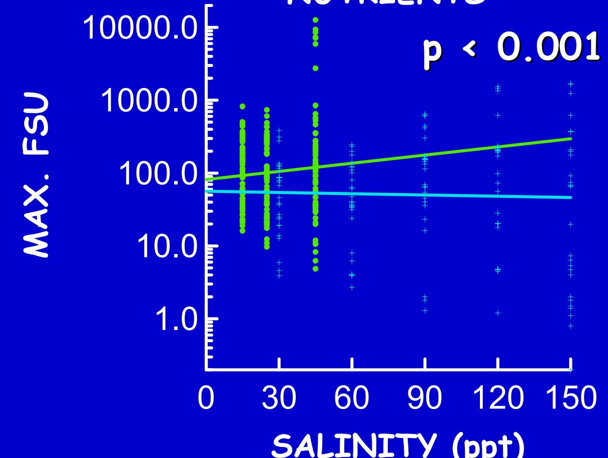
FARMINGTON BAY MORE PRODUCTIVE THAN SOUTH ARM –

more nutrients!



Farmington Bay
South Arm

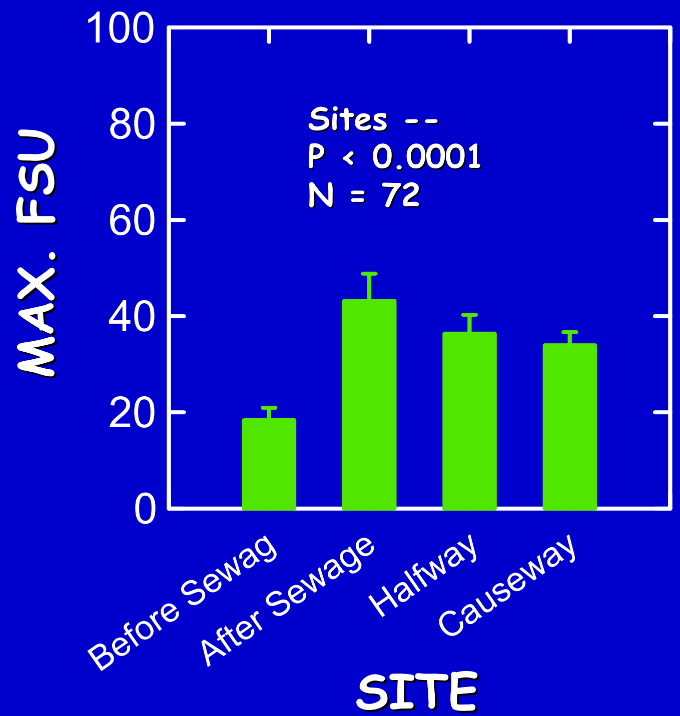


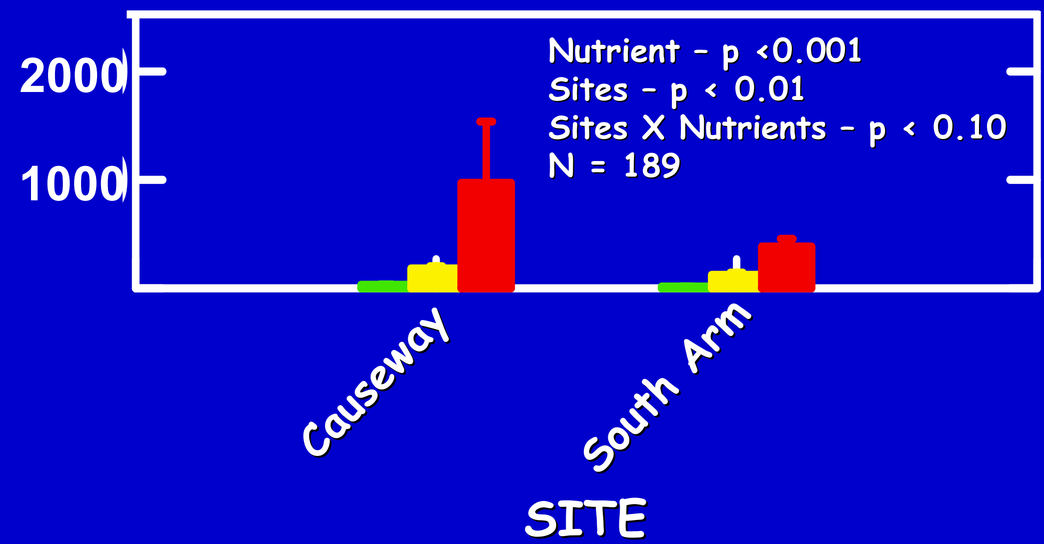


Low = nutrients in lake water
Medium = 50 µm N + 3.2 µm P (16:1 Redfield)
High = 250 µm N + 16 µm P (16:1 Redfield)

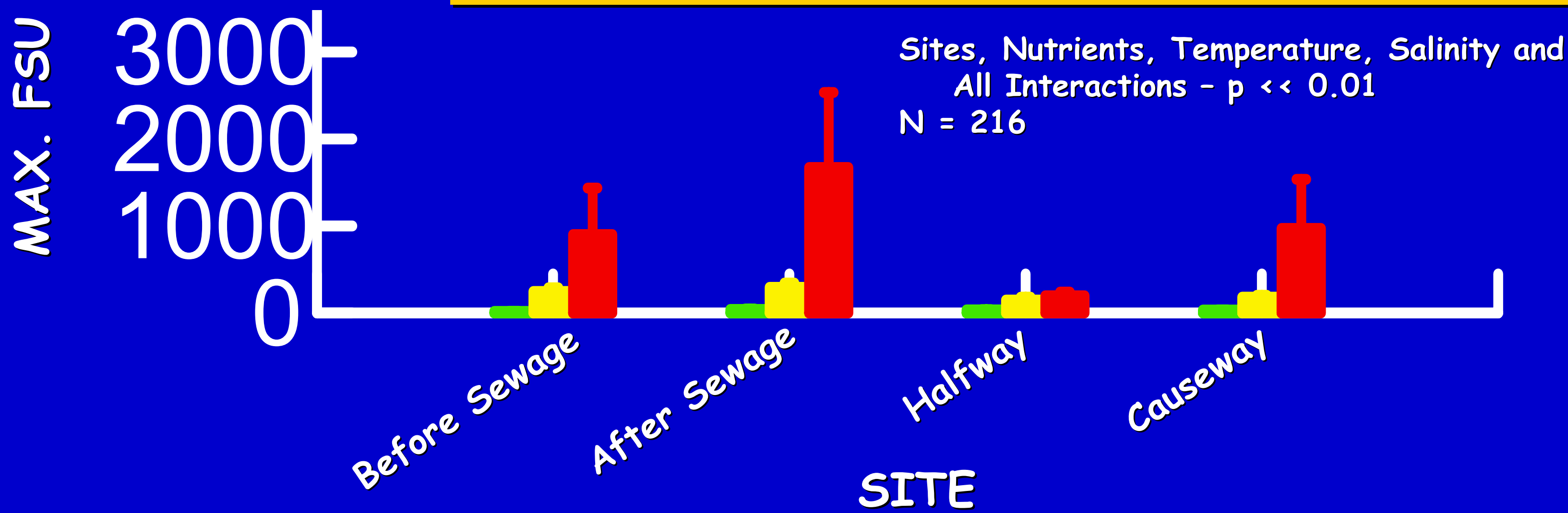
ANCOVA (N = 351):

- Location – $p < 0.003$
- Nutrients – $p < 0.0001$
- Salinity – $p < 0.022$
- Temperature – $p < 0.004$



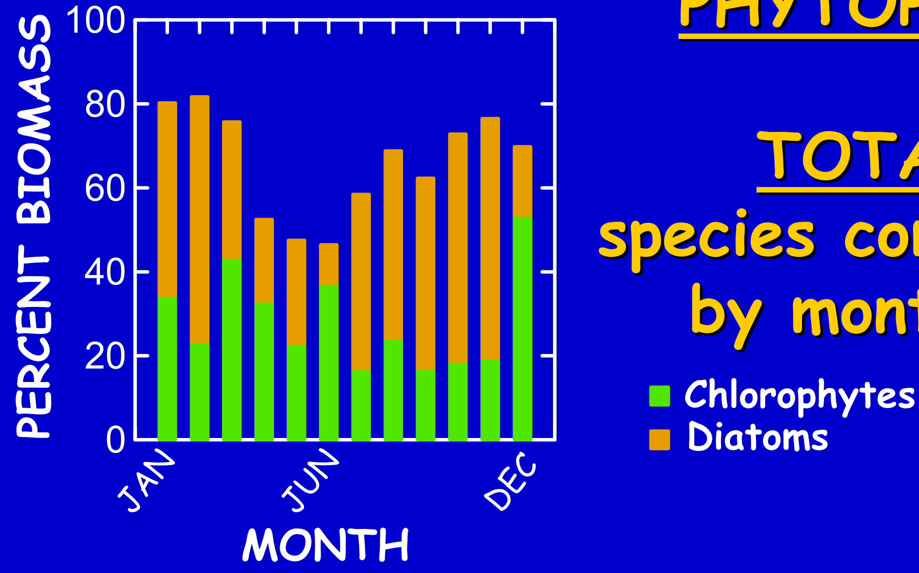


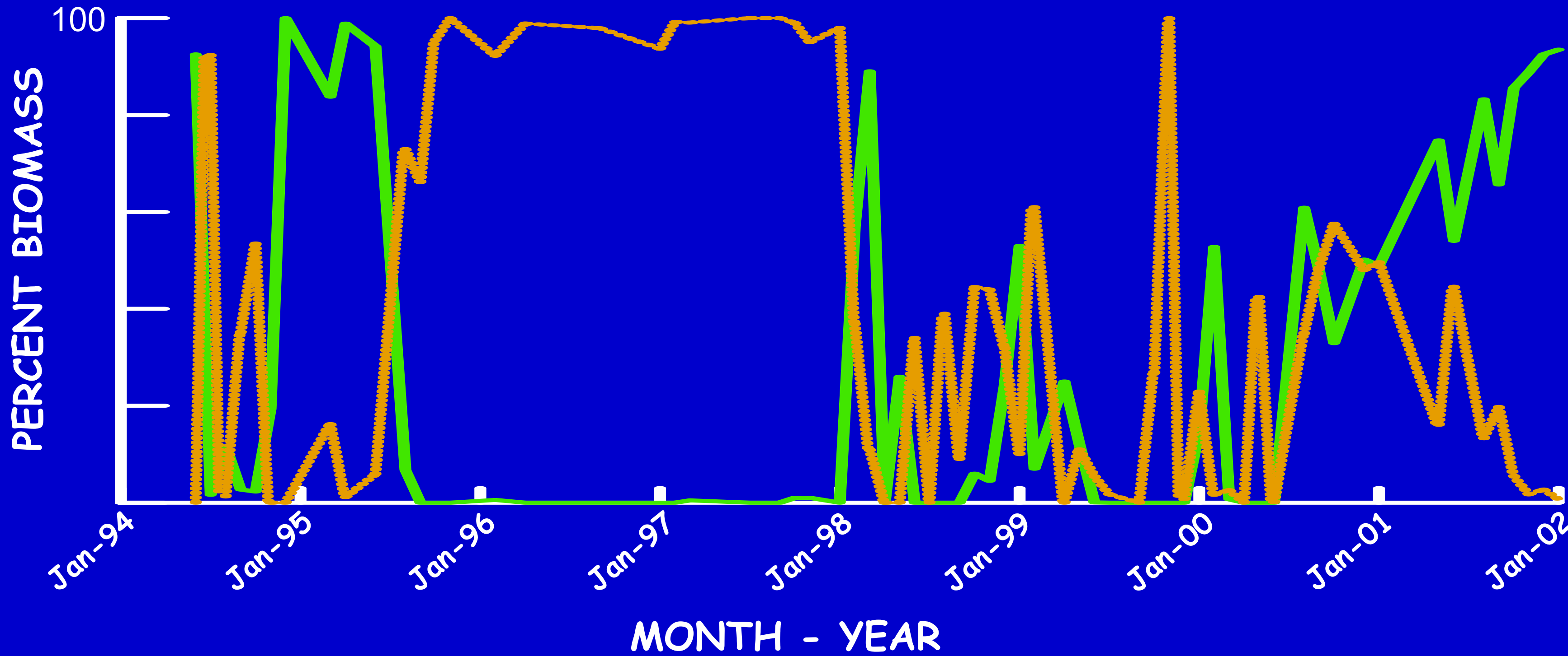
PHYTOPLANKTON PATTERNS AMONG LOCATIONS



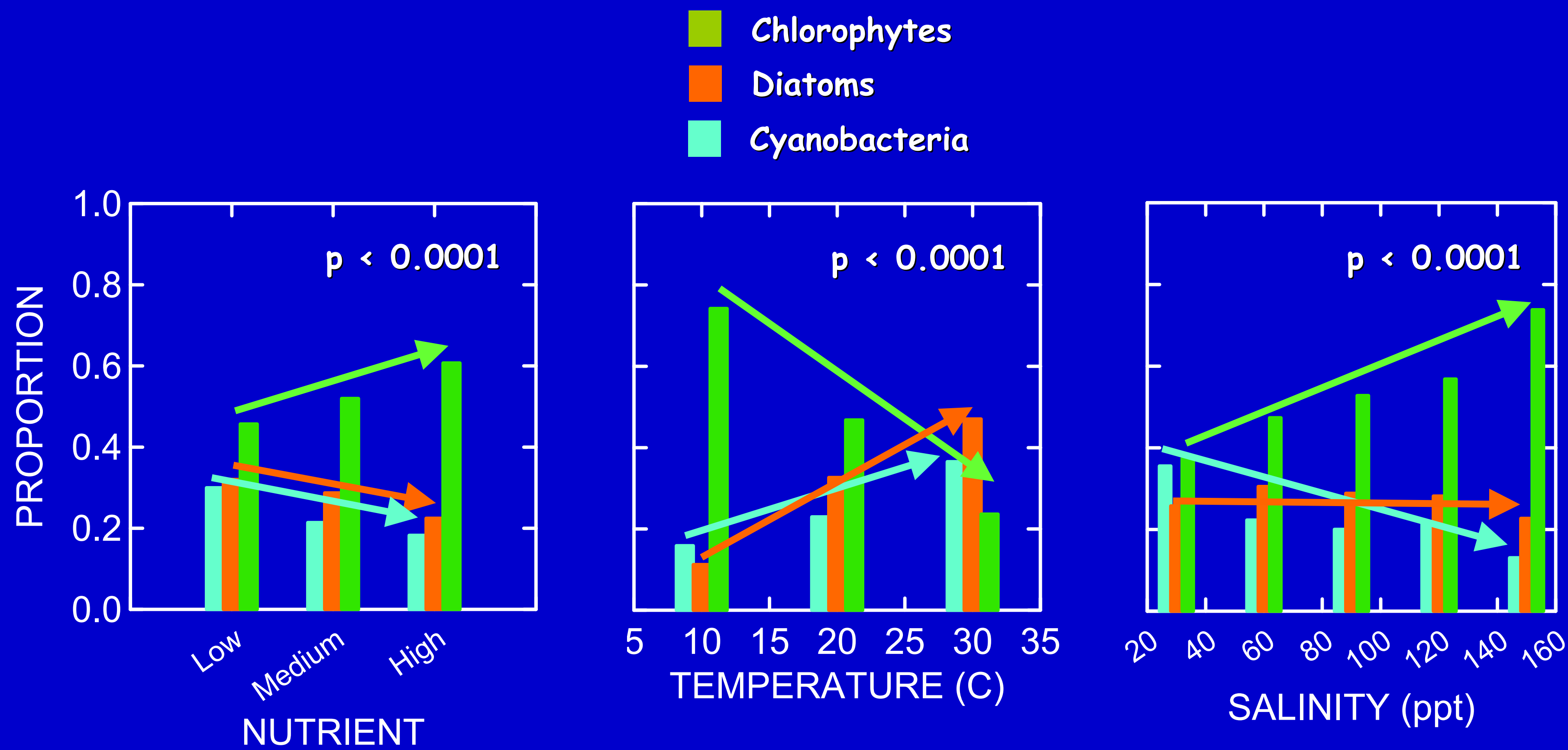
PHYTOPLANKTON VARIABILITY MORE THAN TOTAL ABUNDANCE (CHL_A)

species composition varies dramatically by month and year in South Arm



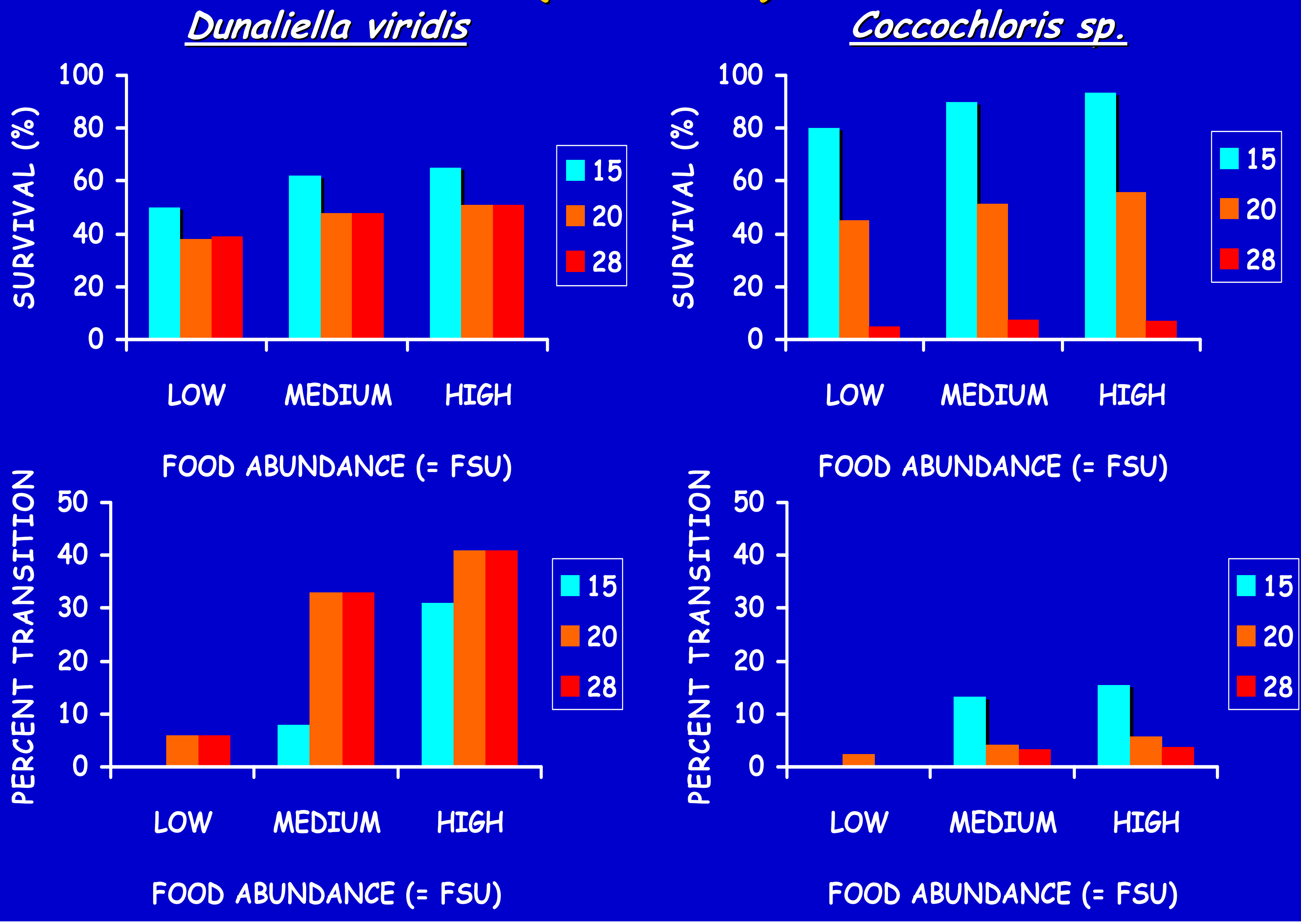


PHYTOPLANKTON COMPOSITION VARIES WITH NUTRIENTS, TEMPERATURE, AND SALINITY IN SOUTH ARM



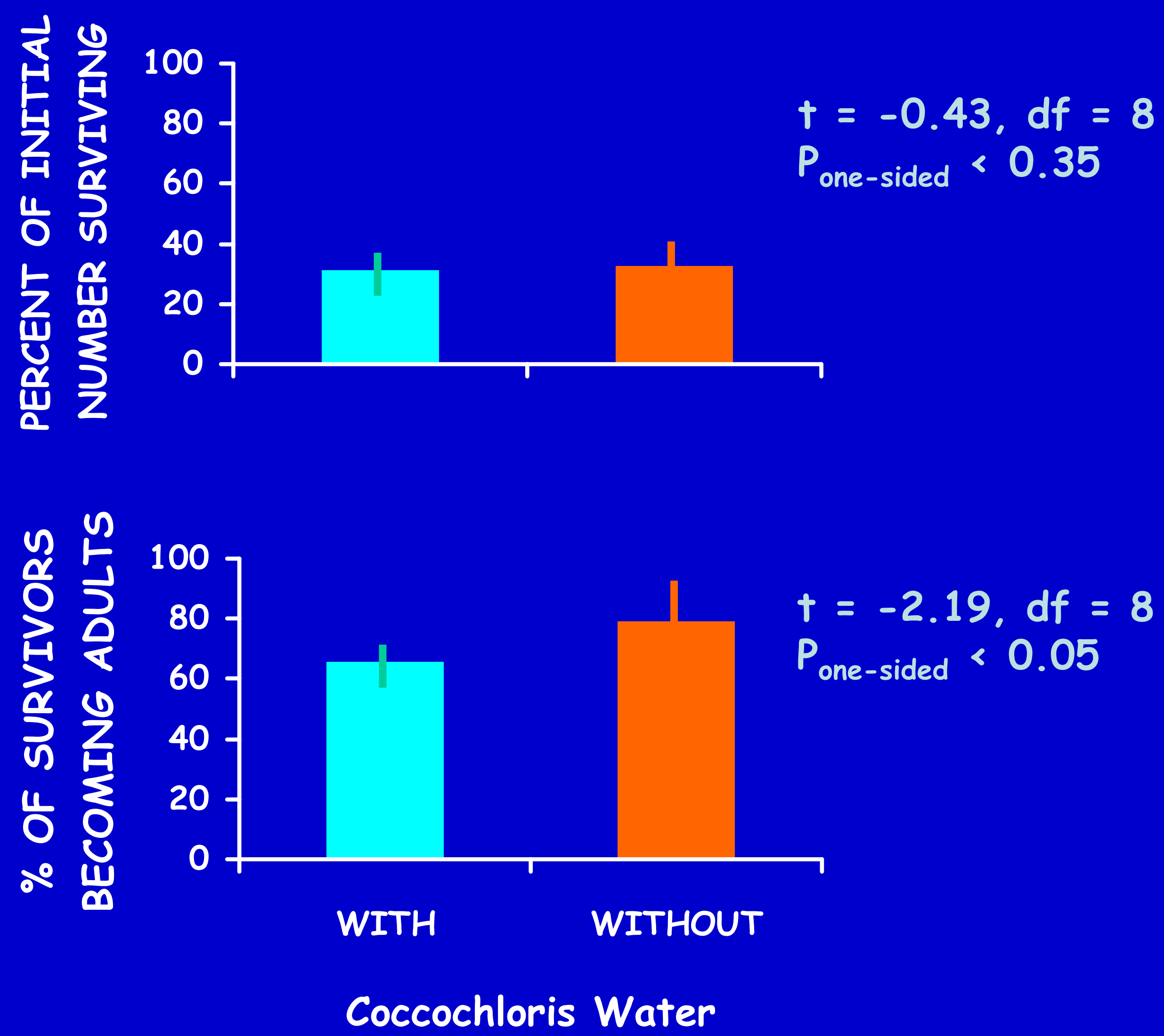
SHRIMP RESPOND TO DIFFERENT FOODS

(Juveniles)



THE WATER MAKES A DIFFERENCE?

(all fed *Dunaliella viridis*)



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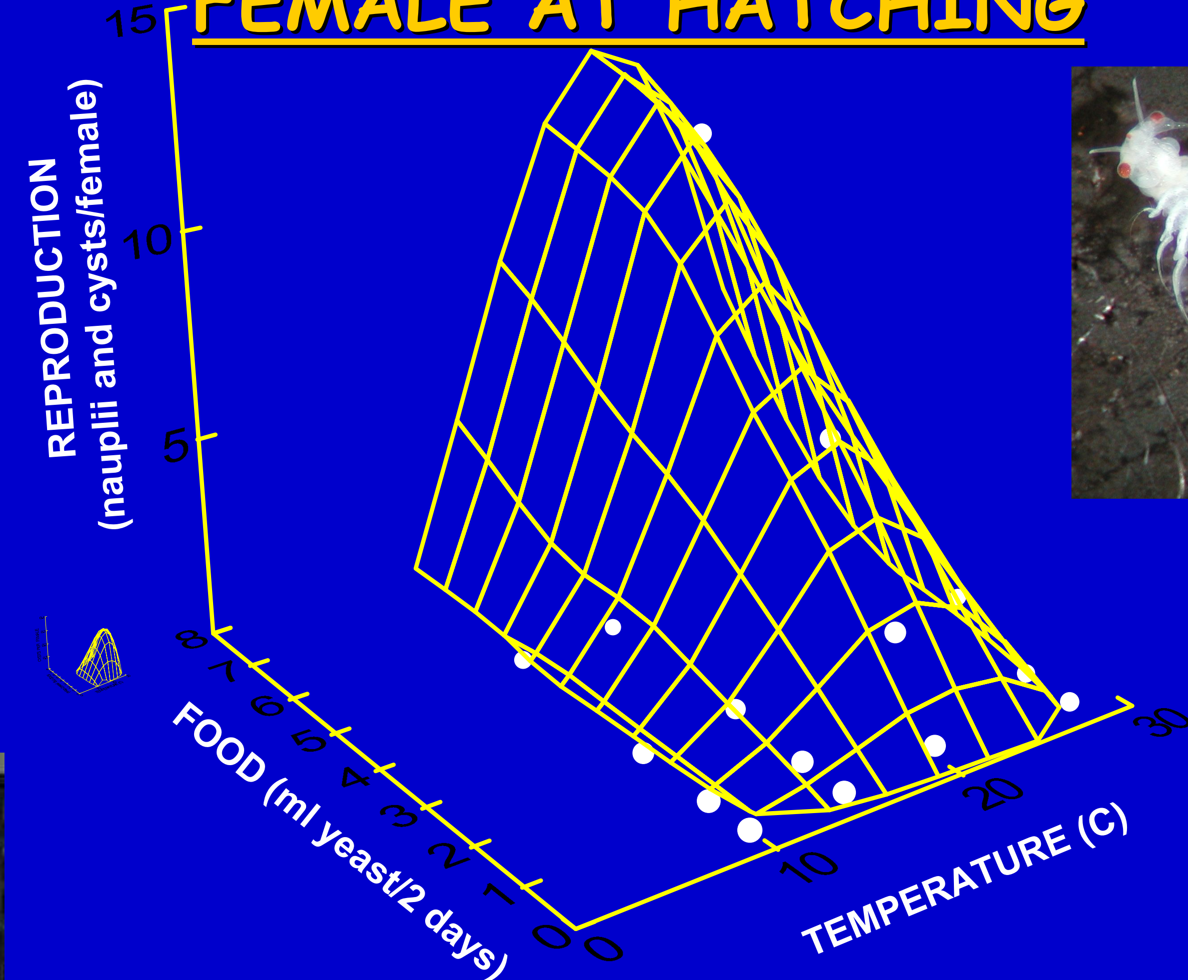

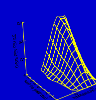

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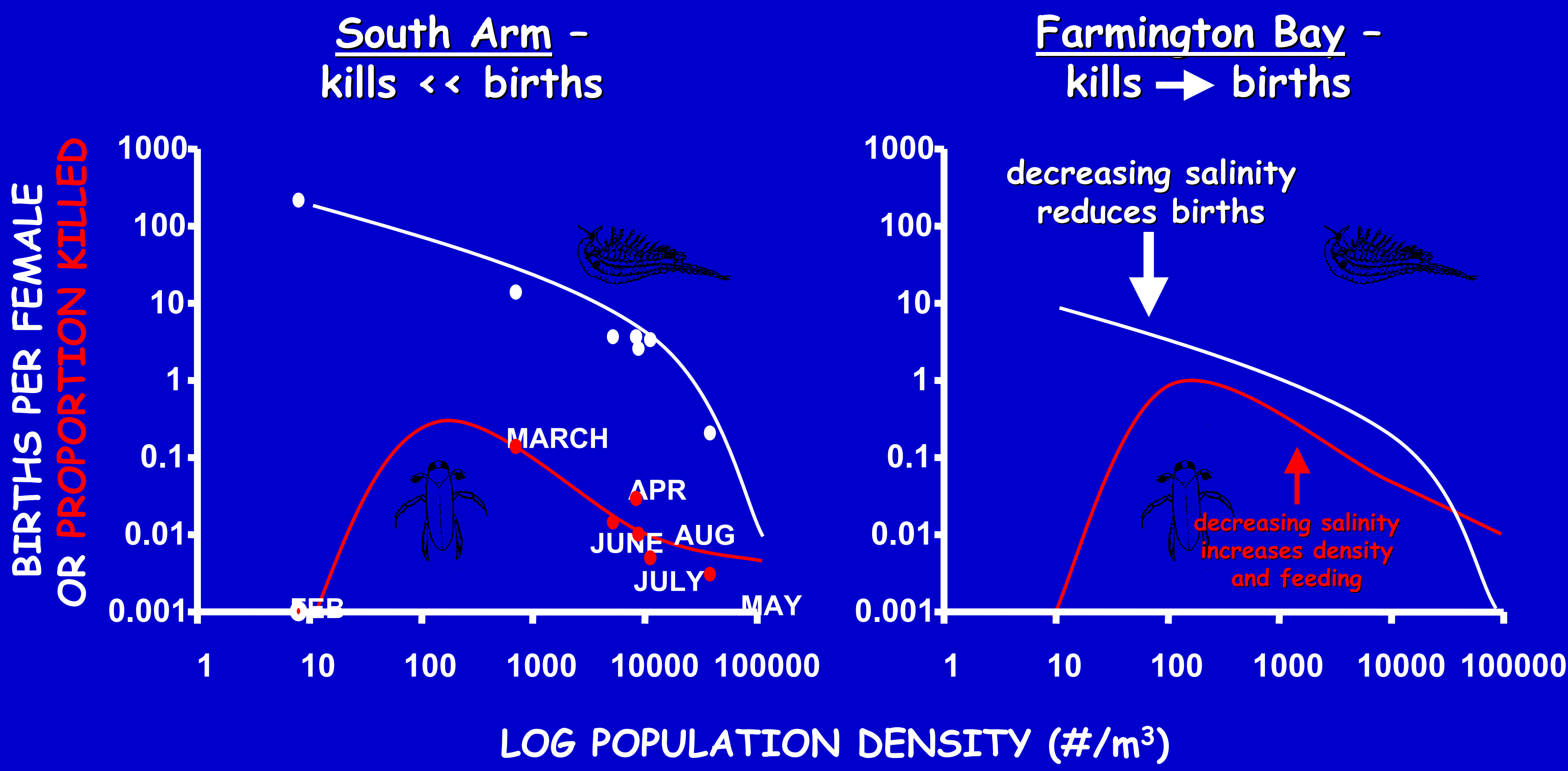
FOR A POPULATION TO BE LIMITED BY PREDATION ONE EXPECTS BIRTH AND PREDATION RATES TO APPROACH EACH OTHER



THE GSL ECOSYSTEM DEPENDS ON MANY INTERACTIONS

GSL ECOSYSTEM PROJECT (UDWR) HAS ASSEMBLED
AN 11 YEAR DATABASE
TO ADDRESS THESE PROCESSES
AND CONTINUES TO BUILD THIS DATABASE
AND TO INVESTIGATE ADDITIONAL PROCESSES