

Climate effects on jellyfish populations: a review

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Why should we care about jellyfish?

- Important consumers of ichthyoplankton and zooplankton (both predators and competitors of fish)
- Great abundances interfere with fishing
- Clog power plant intakes
- Cause health concerns for swimmers, reduce tourism
- Generally detrimental to human enterprise, except for jellyfish fisheries

*Chrysaora
hysoscella*

Namibia

Aequorea aequorea

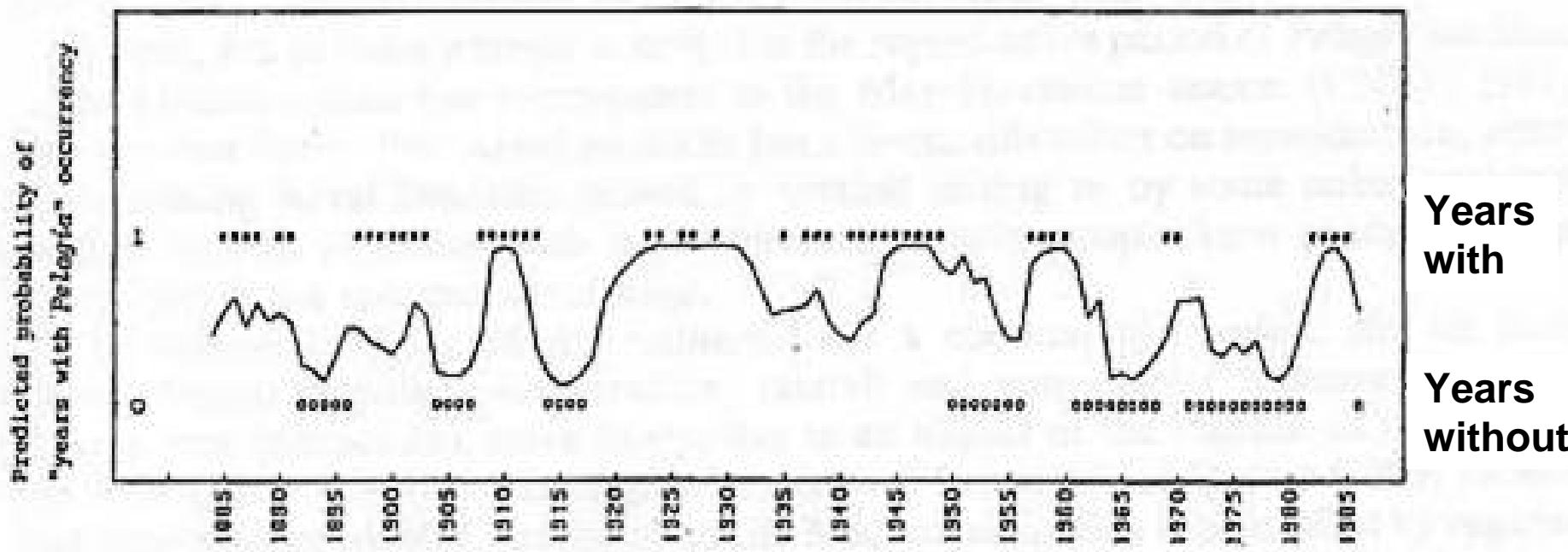


Norway

Periphylla periphylla

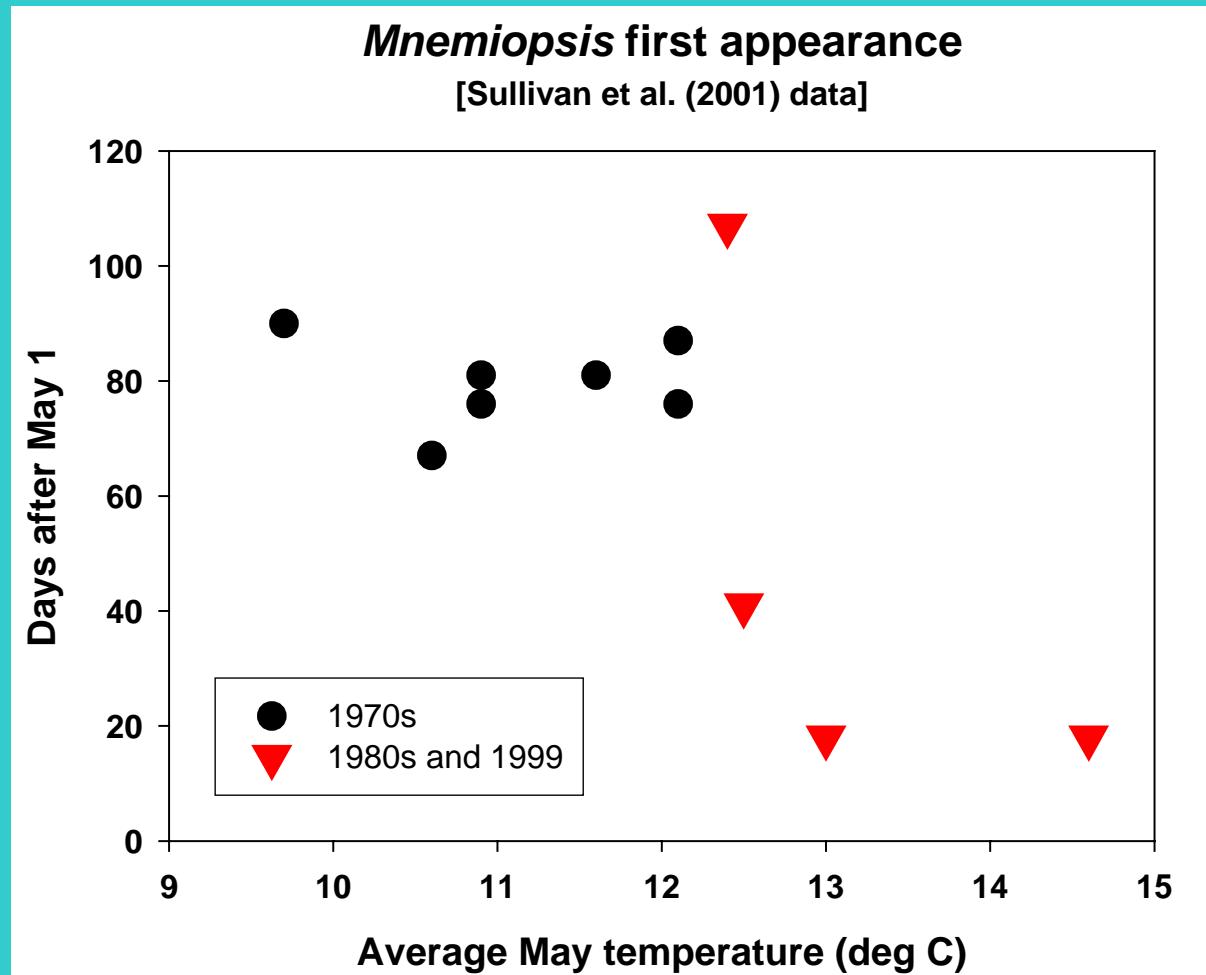


Pelagia noctiluca in the Mediterranean Sea 1805-1985 [from Goy et al. (1989)]



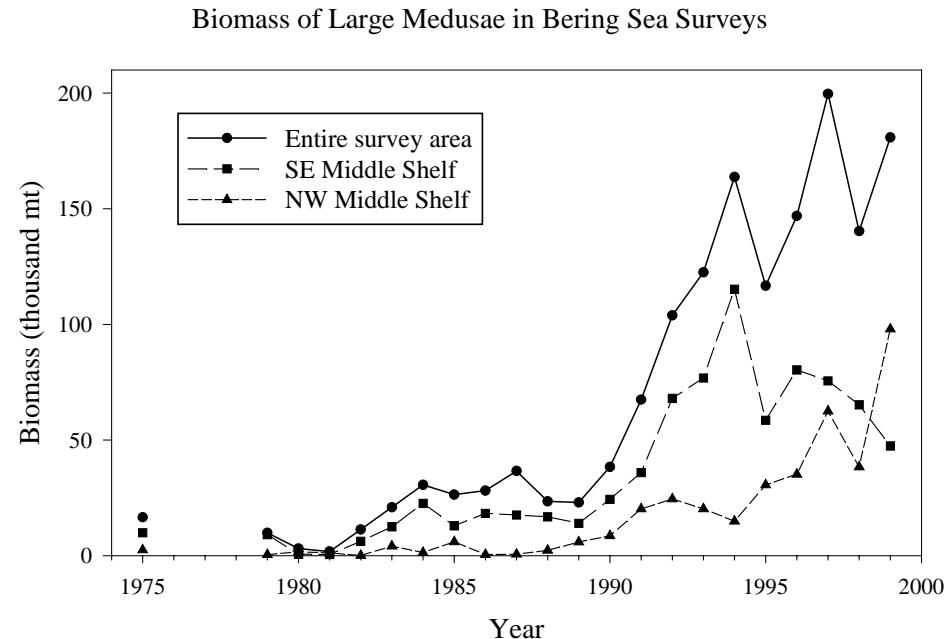
- Warm temperature
- Low rainfall
- High atmospheric pressure

Ctenophore *Mnemiopsis leidyi* in Rhode Island



Significantly earlier appearance, prolonged season
and greater numbers with warmer temperatures

Scyphomedusan *Chrysaora melanaster* in the SE Bering Sea 1975-1999 [from Brodeur et al. (1999)]



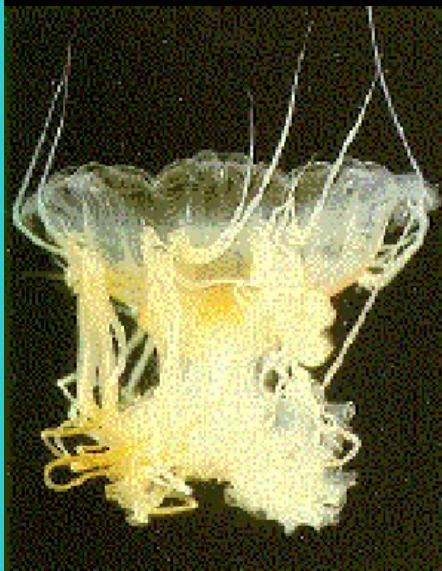
- Warm surface layer and increased stratification leading to greater production
- Release of competition with Age-1 walleye pollock (significant inverse correlation of jellyfish and forage fish biomass)

Significant negative correlation between jellyfish abundance in the North Sea and NAO index 1971-1986 [Lynam et al. (2004)]

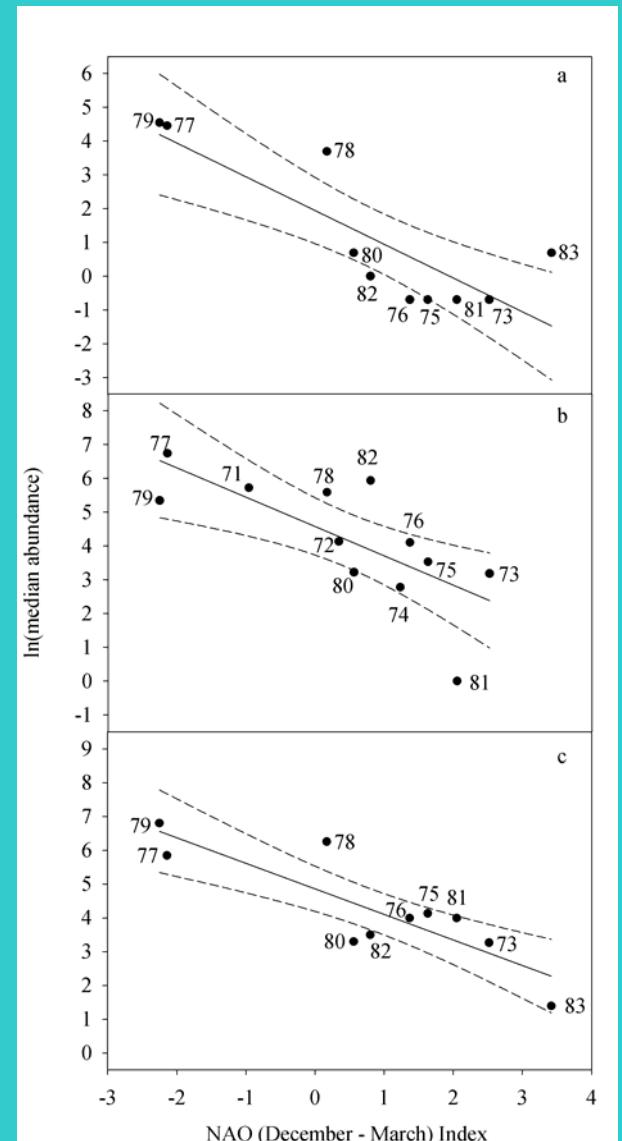
- Calm conditions
- Cool SST



Aurelia aurita
west of Denmark
 $r^2 = 0.70$

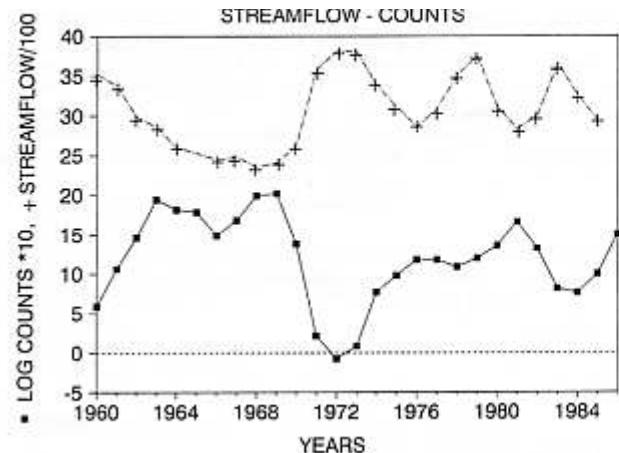


Cyanea lamarckii
west of Denmark
 $r^2 = 0.74$

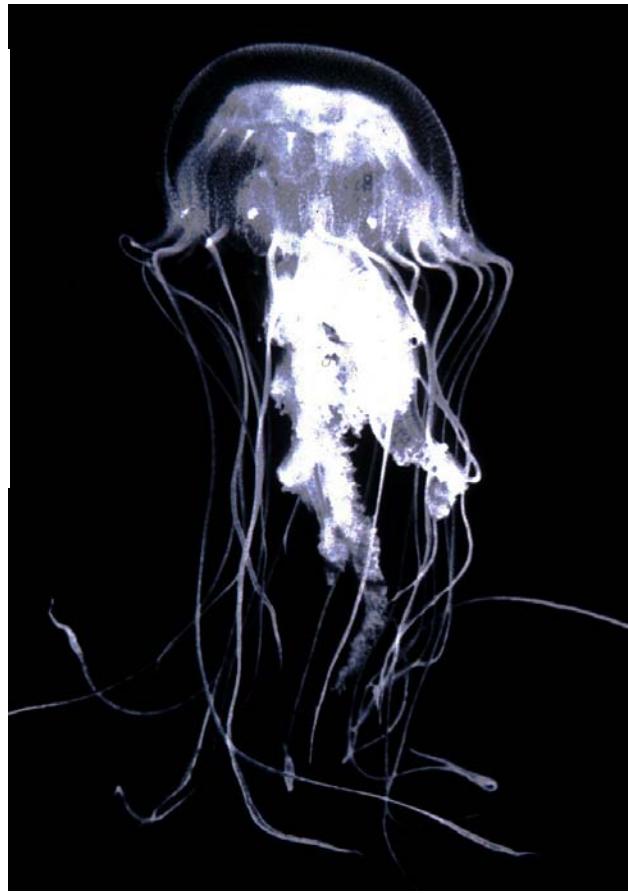
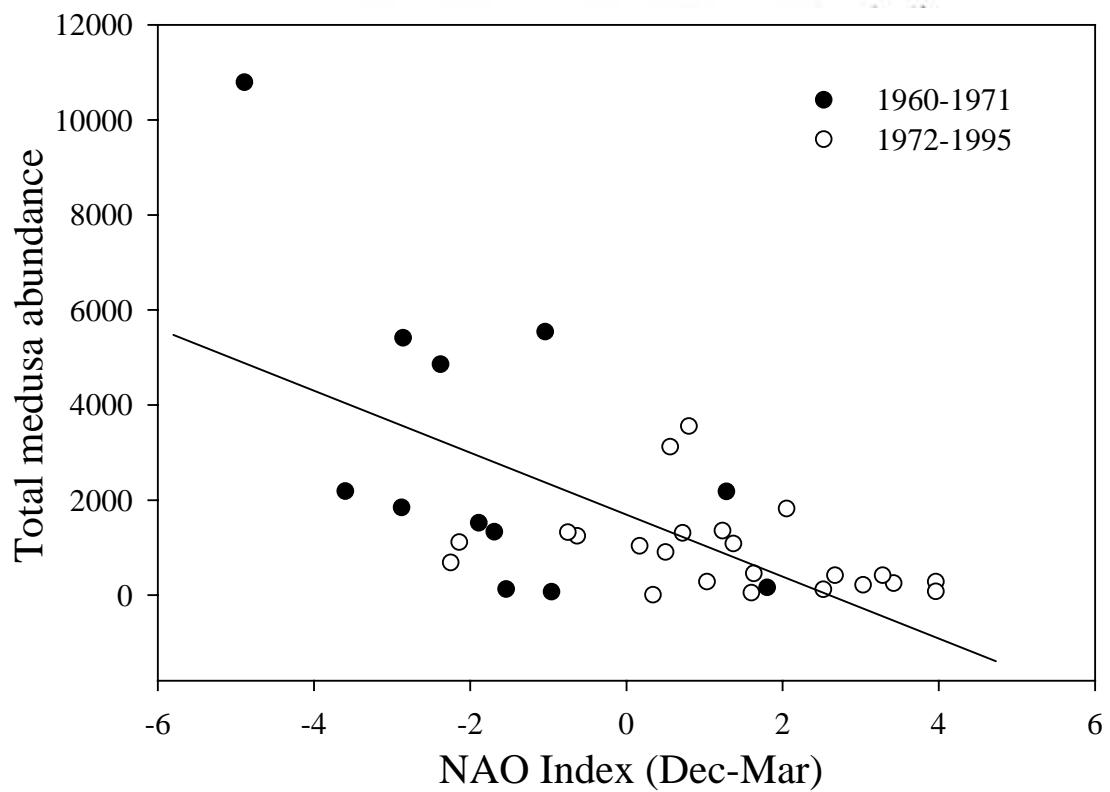


Chrysaora quinquecirrha in Chesapeake Bay 1960-1995

From Cargo
& King (1991)



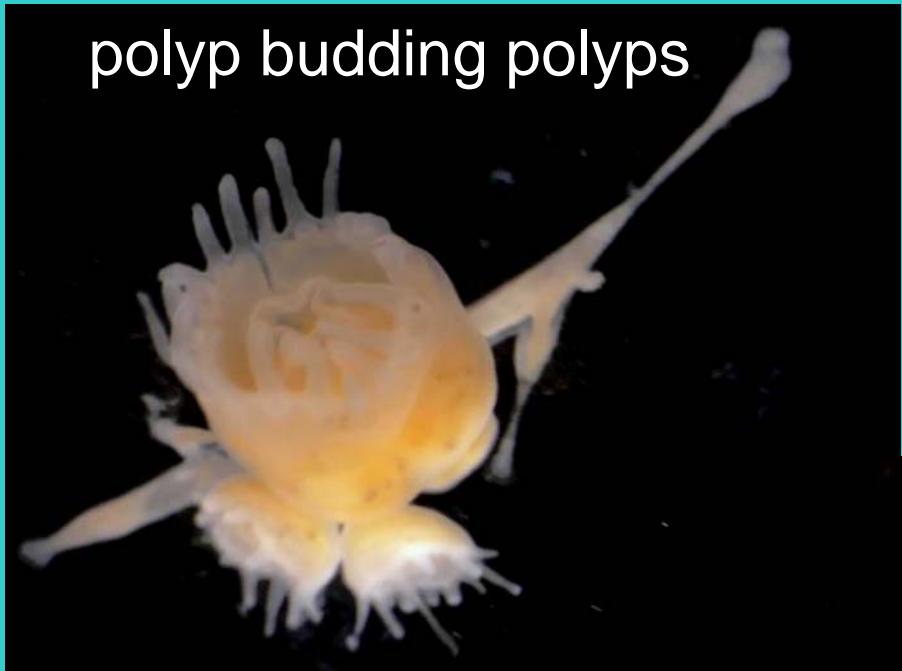
From Purcell &
Decker (2005)



- Low Jan-Jun streamflow
- High salinity
- Warm May temperature
- Negative NAO index

Asexual budding of benthic stage

polyp budding polyps



strobilation

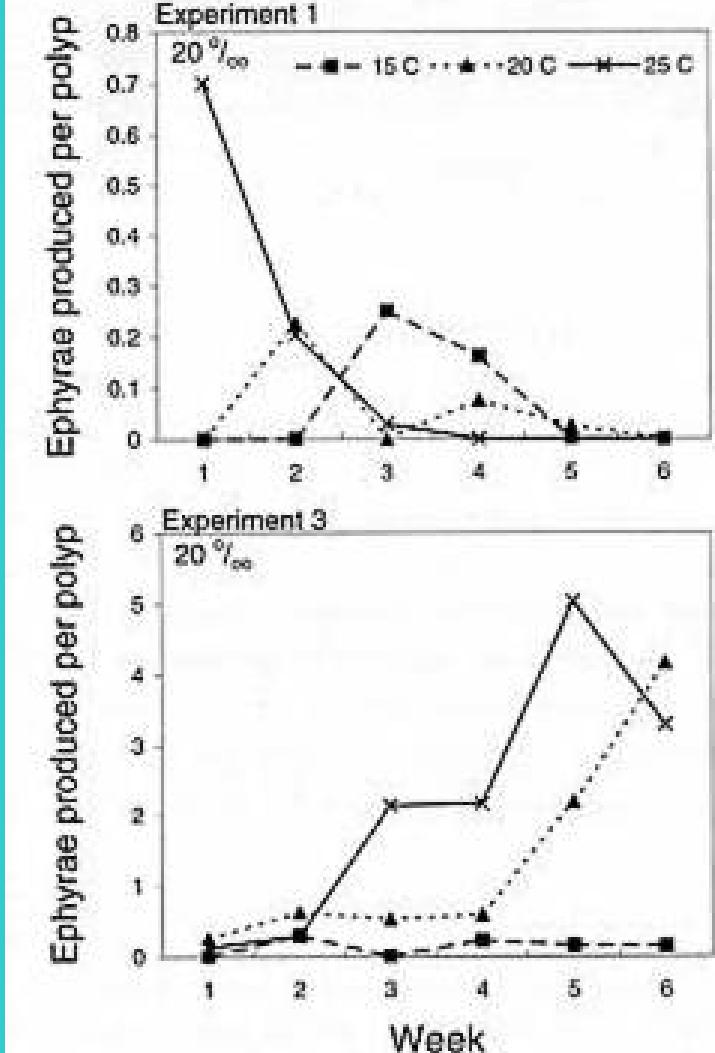
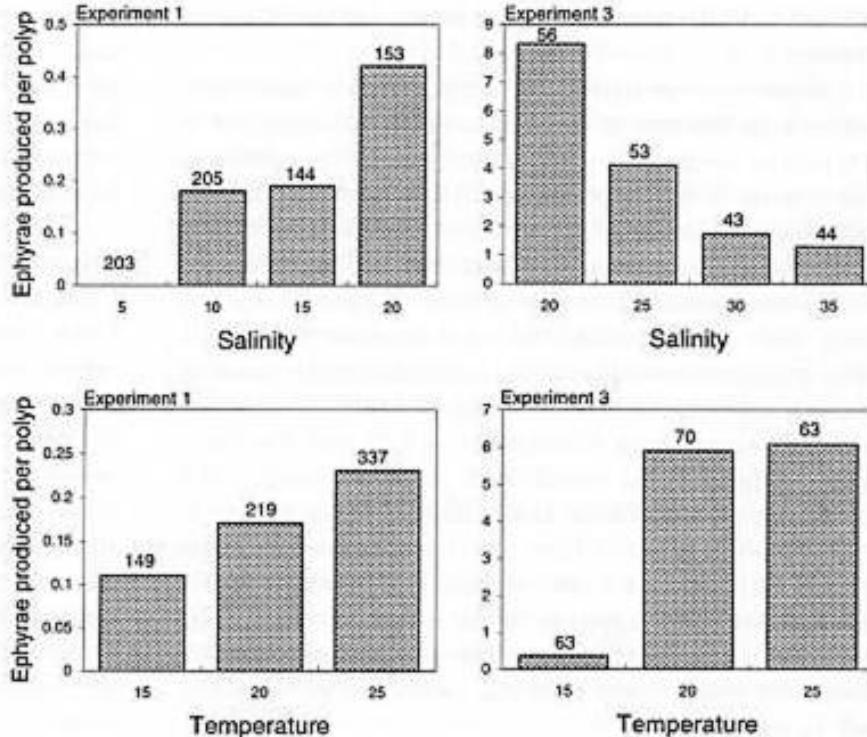


ephyra



Chrysaora quinquecirrha in Chesapeake Bay

[from Purcell et al. (1999)]

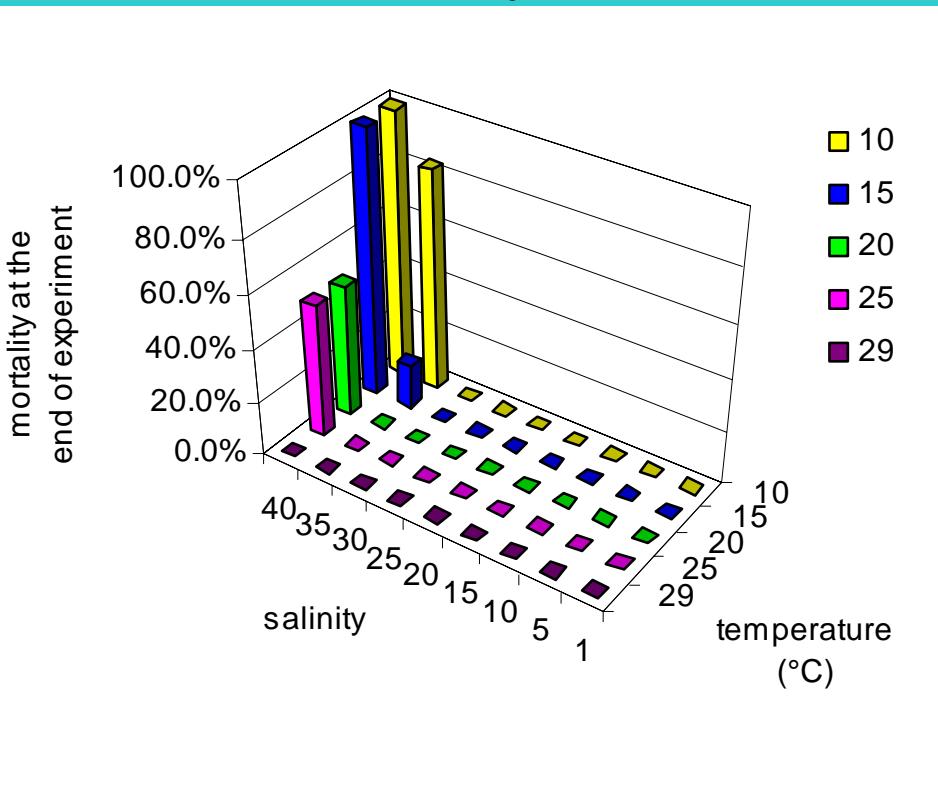


- Salinities between 10 and 25
- Warm temperature increases number of ephyrae and reduces time to budding

Hydrozoan *Moerisia lyonsi* in Chesapeake Bay

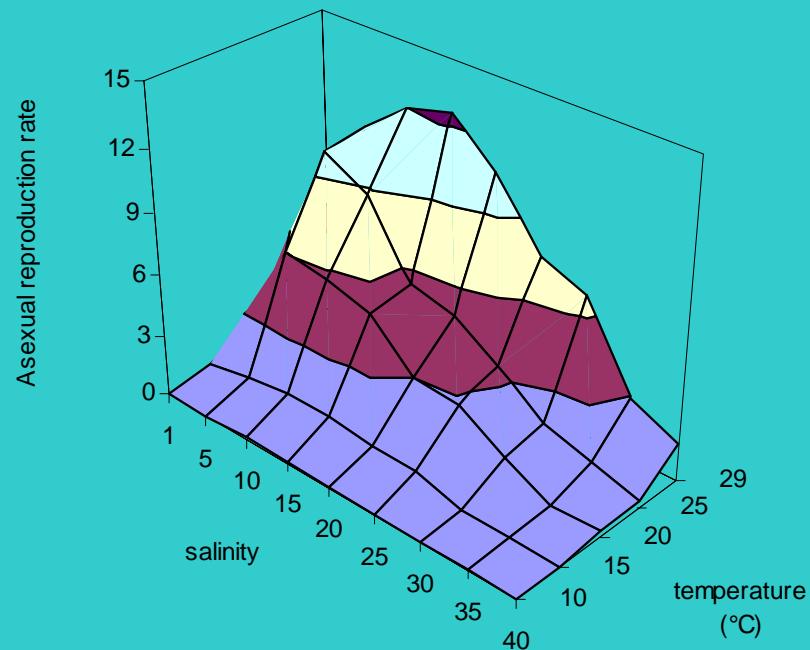
[from Ma & Purcell (submitted)]

Mortality

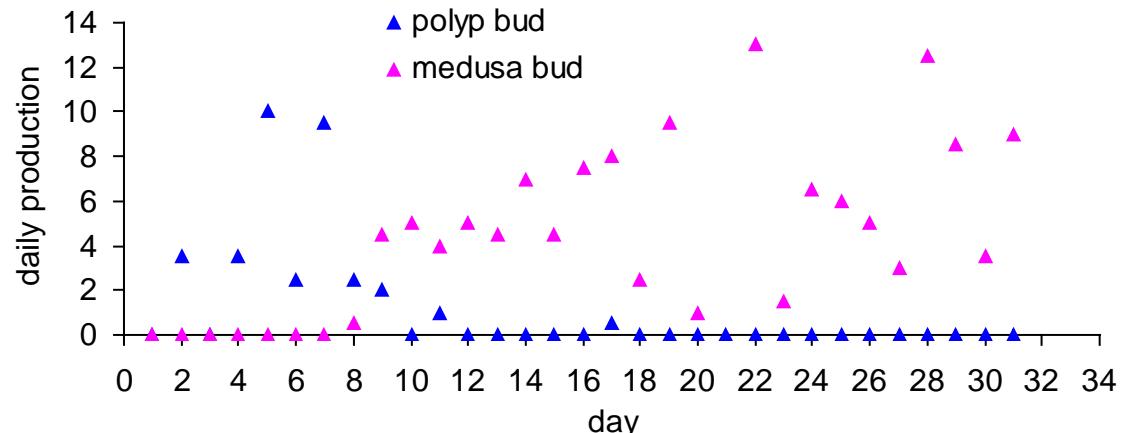


After 7 d following direct transfer
from 20°C and 10 salinity

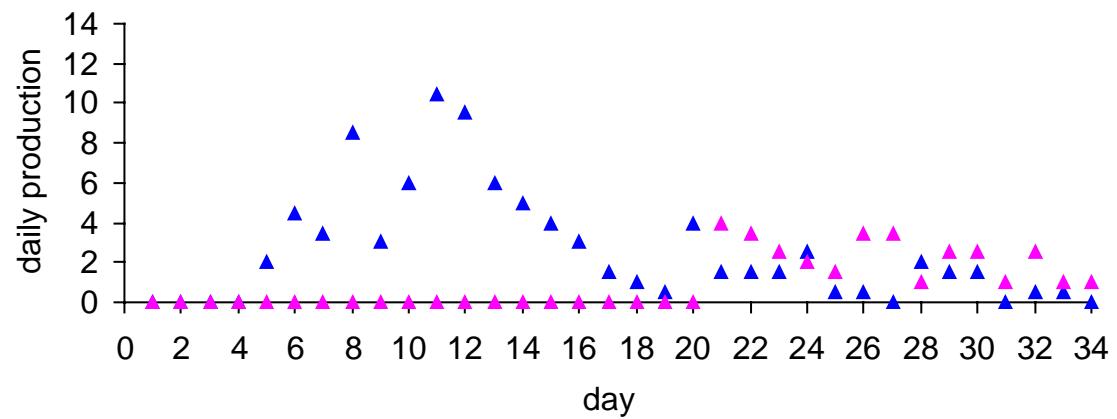
Asexual reproduction



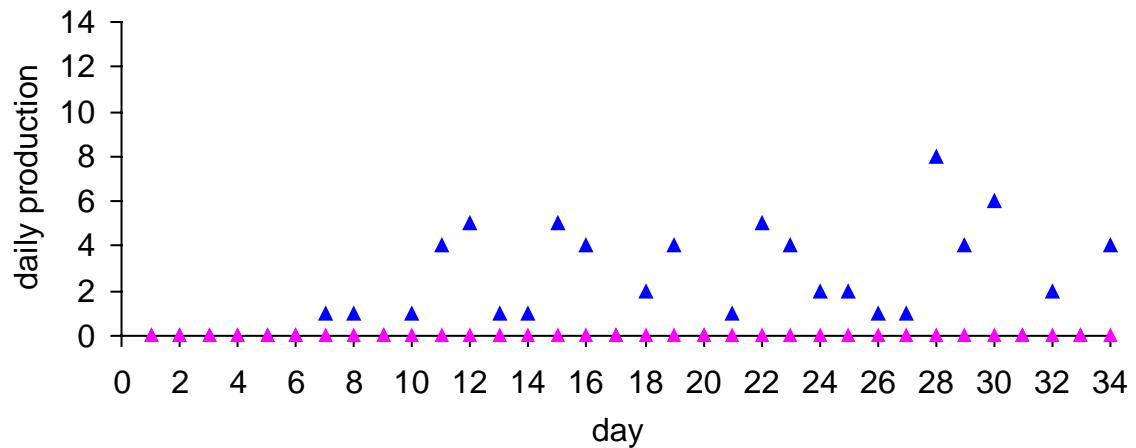
- Moderate salinities
- Warm temperatures



3 factors favorable
 temperature = 29°C
 salinity = 5
 food = 13.4 prey d⁻¹
 medusae/total buds = 0.78



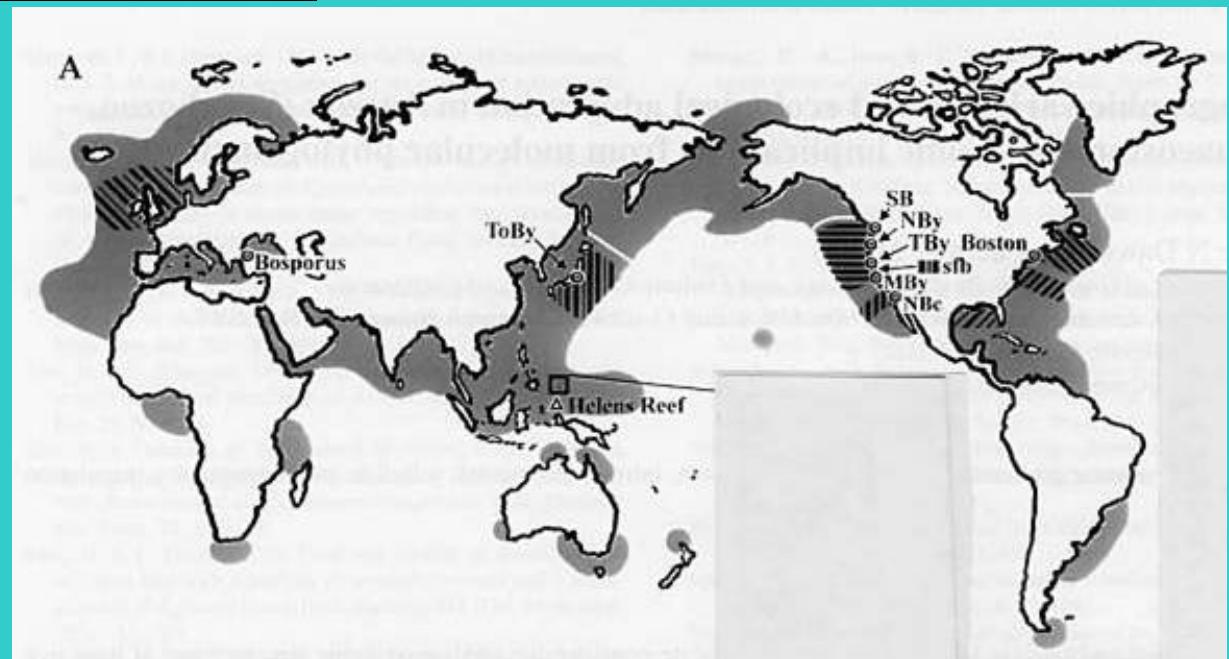
2 factors favorable
 temperature = 20°C
 salinity = 5
 food = 11.1 prey d-1
 medusae/total buds = 0.24



1 factor favorable
 temperature = 20°C
 salinity = 25
 food = 7.8
 medusae/total buds = 0



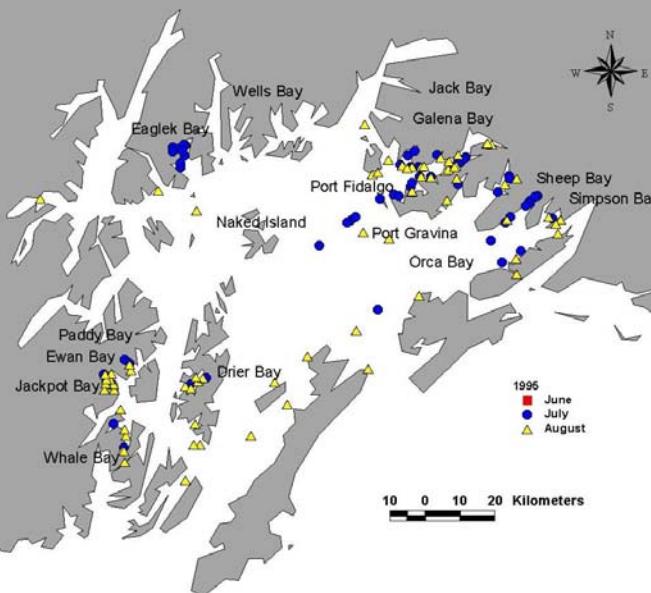
Aurelia spp. around the world



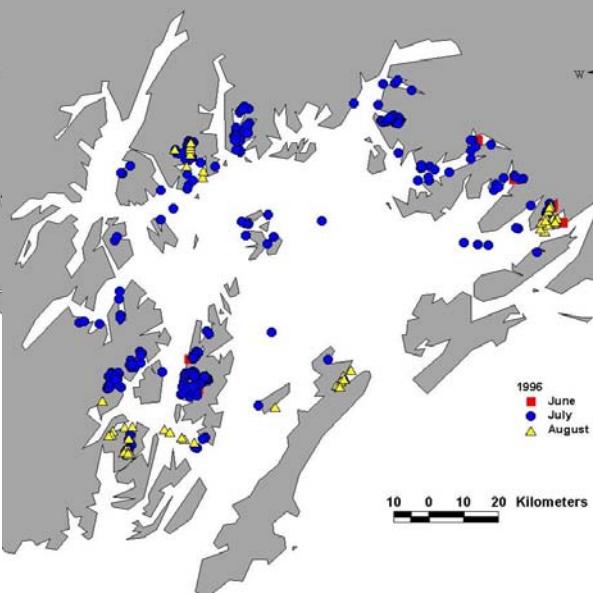
[map from Dawson & Martin (2001)]

Aggregations of *Aurelia labiata* in Prince William Sound, AK

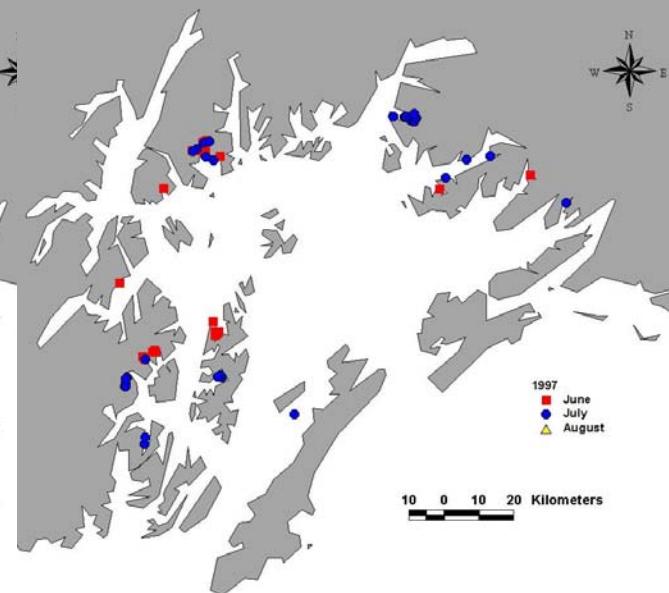
1995



1996



1997



94

493

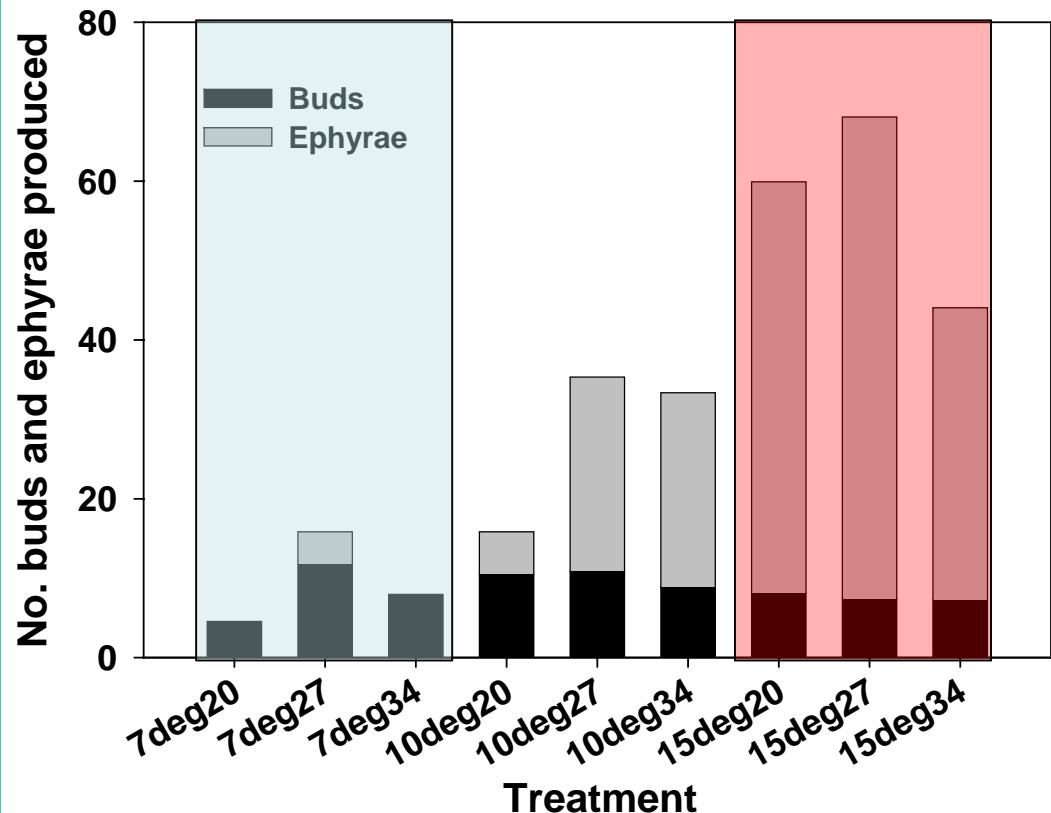
28

1998 = 770

From Purcell
et al. (2000)

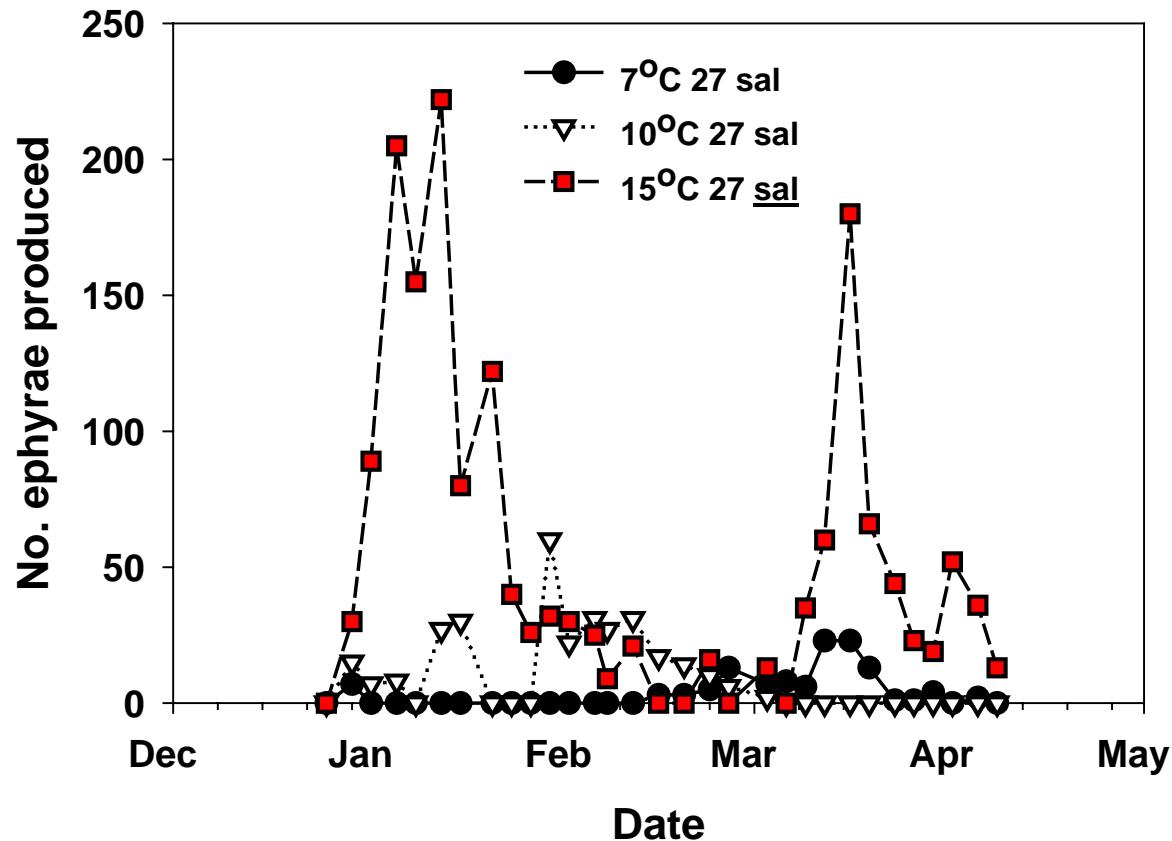


Aurelia labiata
 total polyp & ephyra
 production 104 d
 7, 10, 15°C
 20, 27, 34 ppt
 (n = 24)



| | Temp. | Salinity | Interaction |
|------------|---------|----------|-------------|
| # Buds | <0.0001 | <0.01 | <0.001 |
| # Ephyrae | <0.0001 | NS | NS |
| Total | <0.0001 | NS | NS |
| Ephy/total | <0.0001 | <0.0001 | <0.0001 |

Aurelia labiata ephyra production over time (n = 24)



| | Temp. | Salinity | Interaction |
|------------------------|---------|----------|-------------|
| # days to strobilation | <0.0001 | NS | <0.01 |
| # days of strobilation | <0.0001 | <0.05 | <0.01 |

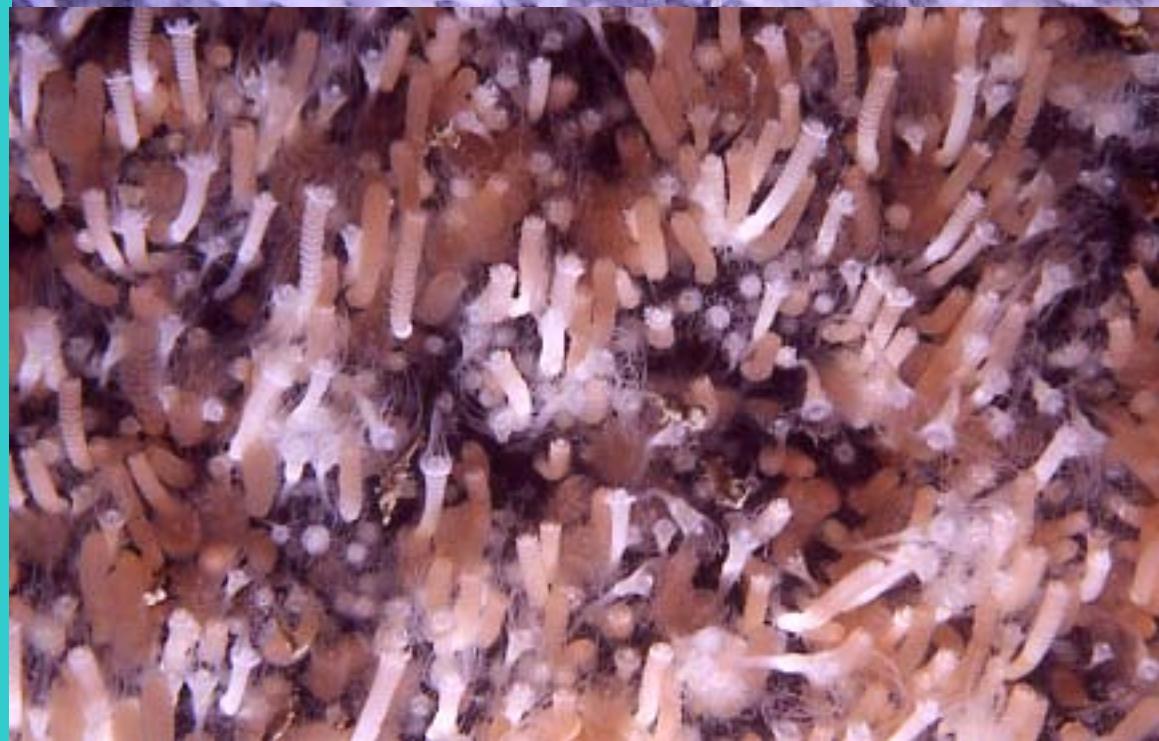
17 Jan 04

Aurelia labiata
10 polyps cm⁻²



17 Feb 04

13.4 disks polyp⁻¹
est. 4,550 ephyrae



Conclusions

- Jellyfish abundances generally increase in warm temperatures, correlated with climate
- Both temperature and salinity significantly affect asexual reproduction
- Warmer temperatures increase the numbers of jellyfish produced, the proportion of medusae, and decrease the time to initiate and complete strobilation
- The amount of food available also is a critical factor

How humans may be increasing jellyfish populations

Action

- Global warming
- Eutrophication (sewage, fertilizers)
- Depleting commercial species (fishing)
- Introducing species
- Building structures (marinas, oil rigs)

Effect

- Faster population growth
- Increased food and turbidity, reduced prey size and oxygen favor jellies over fish
- More food for jellies and removal of predators
- More food, no predators
- More substrate for polyps