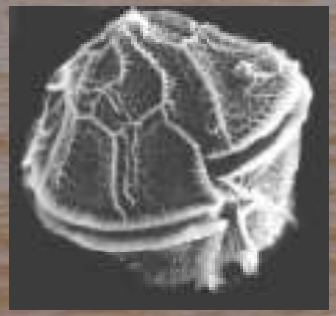
Desalination: Potential Impacts Related to Harmful Algal Blooms



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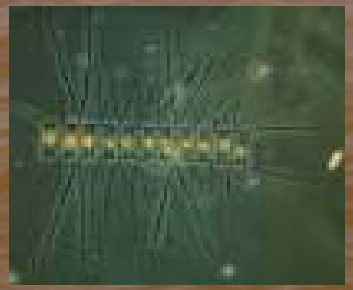
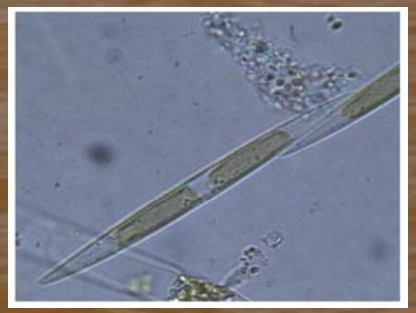
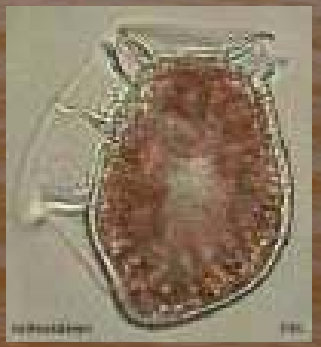






Local HAB issues of relevance

I) Massive, but relatively non-toxic blooms

1a) non-toxic 'red tides'

Prorocentrum spp., *Noctiluca* scintillans

(& several other dinoflagellates)

1b) noxious 'foams', 'scums', and fouling materials

Phaeocystis globosa, Tetraselmis sp.

2) Toxin-producing species

Alexandrium spp. (Paralytic Shellfish Poisoning)

Pseudo-nitzschia spp. (Amnesic Shellfish Poisoning)

Dinophysis spp. (Diarrhetic Shellfish Poisoning)

Lingulodinium polyedrum (Yessotoxin)

Some 'newcomers' on the scene.

Potential issues for RO desal

I) Massive, but relatively non-toxic blooms

Impacts on intake/desal process.

2) Toxin-producing species

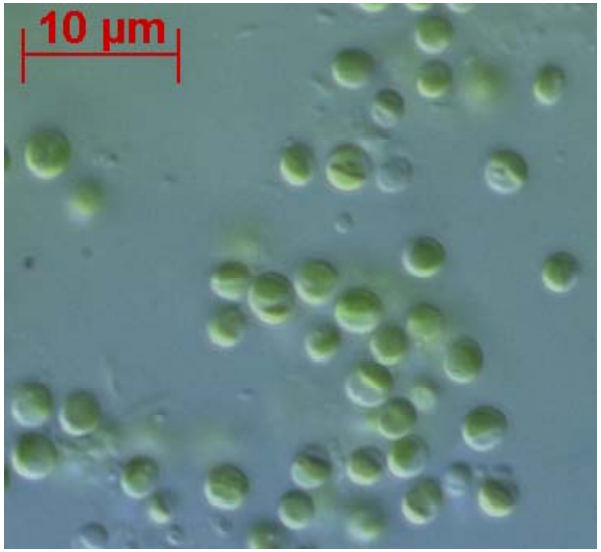
Impact on permeate quality.

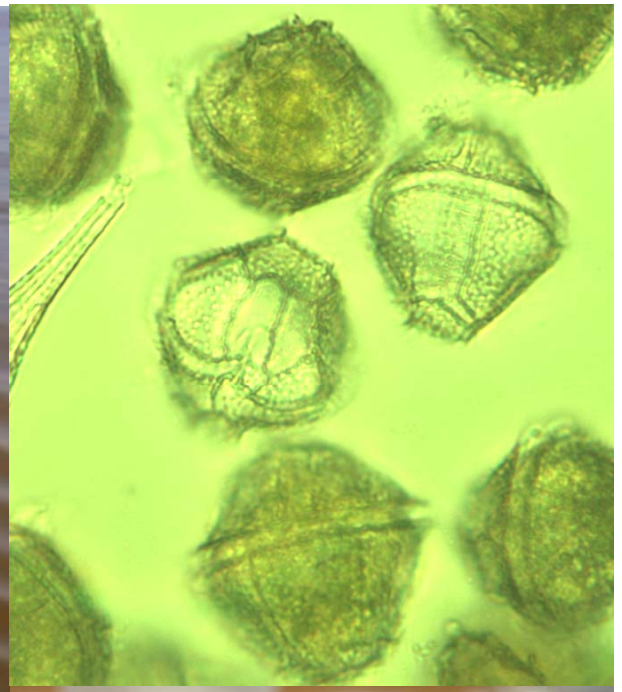
Potential increased toxicity of brine.

Massive ‘red tide’ off CA caused by the dinoflagellate *Noctiluca* (colorful, fairly innocuous, but lots of biomass accumulation)

Tetraselmis : The ‘green scums’ of recent summers.

[Scientist IDs mysterious ocean scum](#)
The Orange County Register, July, 2010

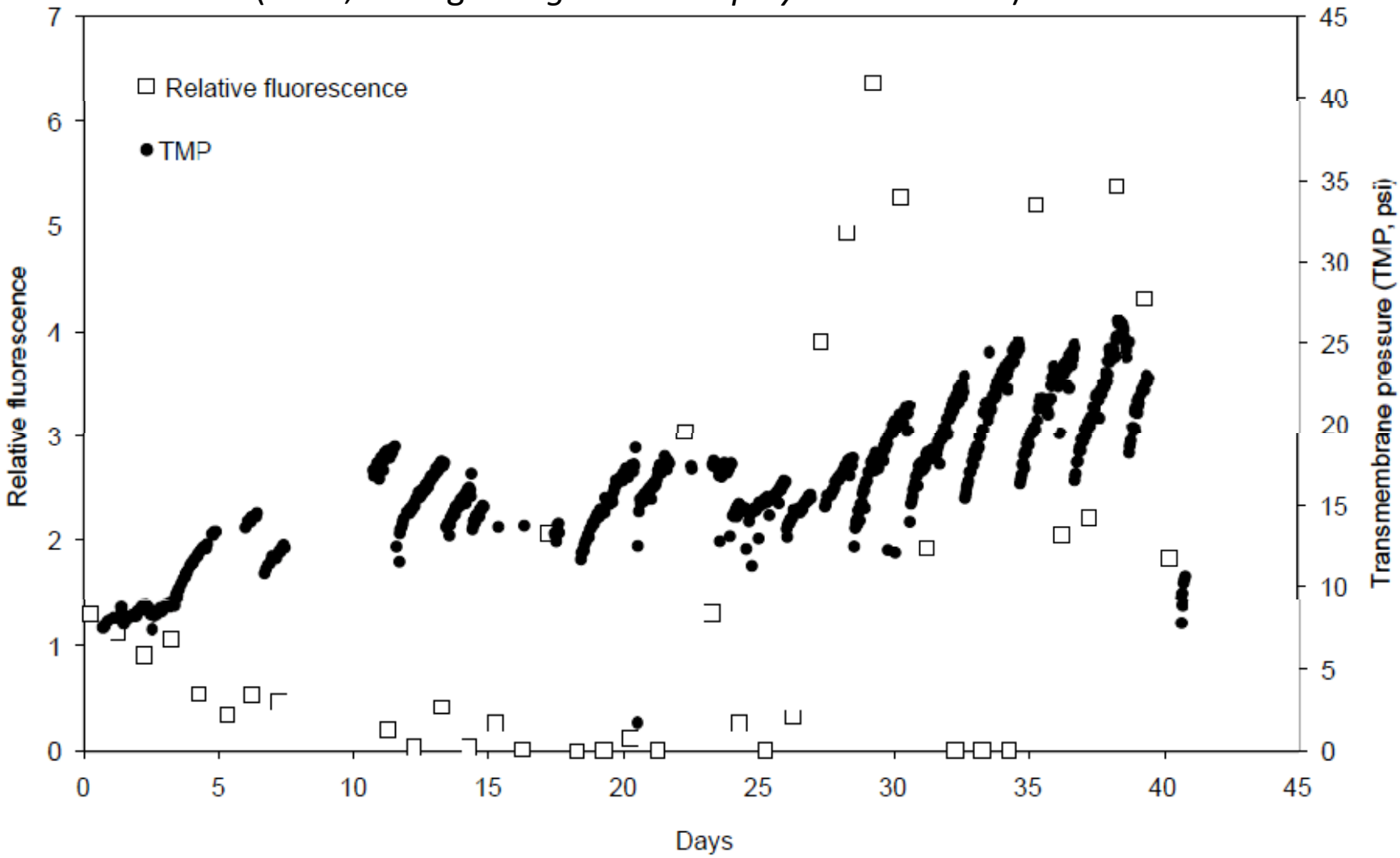




Local bloom of
Lingulodinium polyedrum

Loading of phytoplankton onto a pilot-scale reverse osmosis desalination system and resulting transmembrane pressure.

(2005, during a *Lingulodinium polyedrum* bloom)



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Red tides close desal plants
Water Desalination Report
Vol. 44 Dec 2008

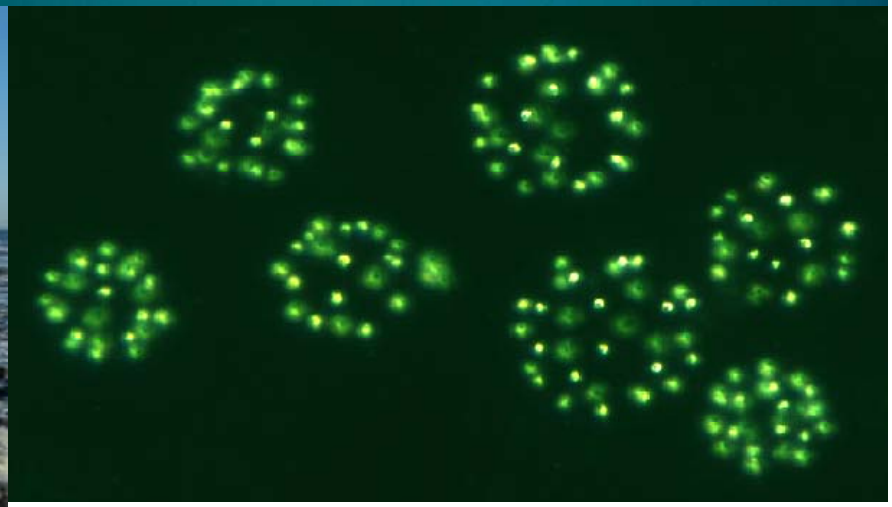
United Arab Emirates

"A red tide that local officials described as being 'the worst in years' has closed several seawater desalination plants and has impacted operations…"

The bloom forced the closures of at least five seawater desalination plants in the UAE due to clogging of intake filters, concerns that the bloom would irreversibly foul reverse osmosis membranes, or other operational problems caused by the dense blooms.

Oman 2008.

The Abu Dhabi Water Resources Master Plan estimated losses of more than US$100,000 a day for the industry.



Noxious species; disruption of normal food web structure and function.
Dimethyl sulfide

Potential issues for RO desal

I) Massive, but relatively non-toxic blooms

Impacts on intake/desal process.

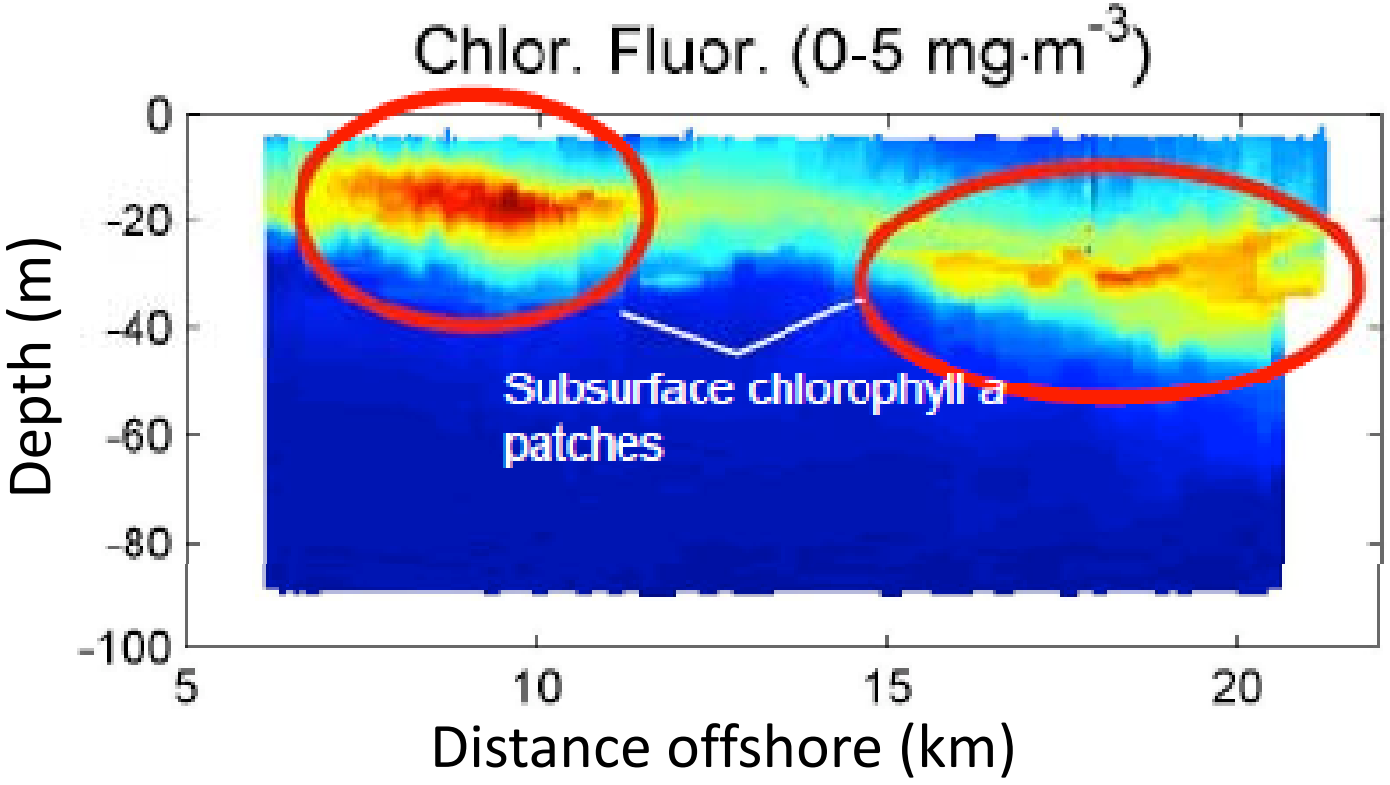
Possible Approaches:

Cessation of operations.

Pre-filtration approaches.

Alternate intake? (plant design issue).

Subsurface accumulations of algae should be considered in the placement of intake (and discharge) pipes.



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Potential issues for RO desal

I) Massive, but relatively non-toxic blooms

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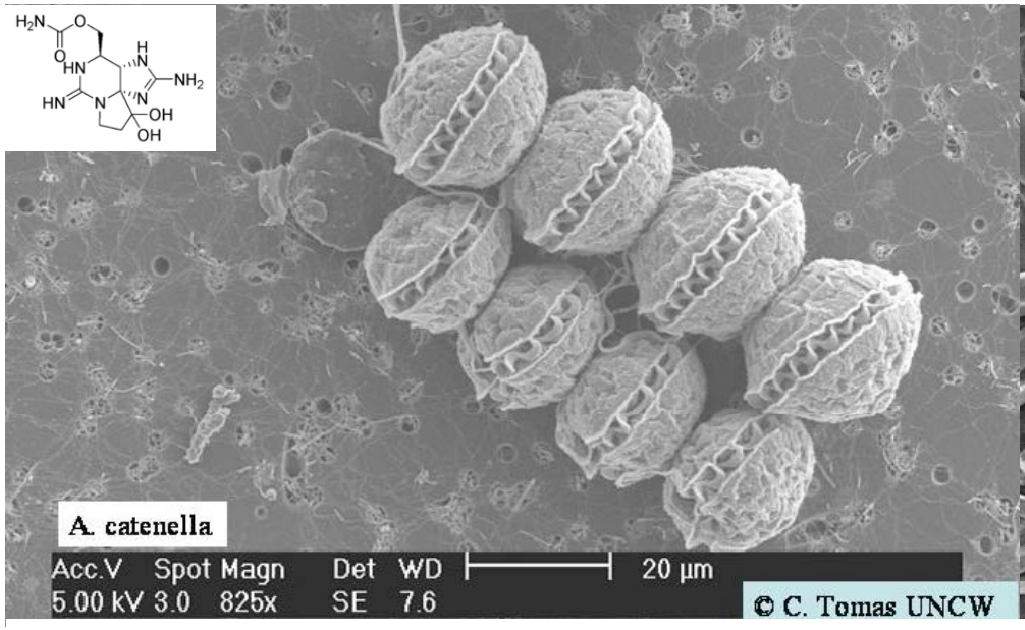
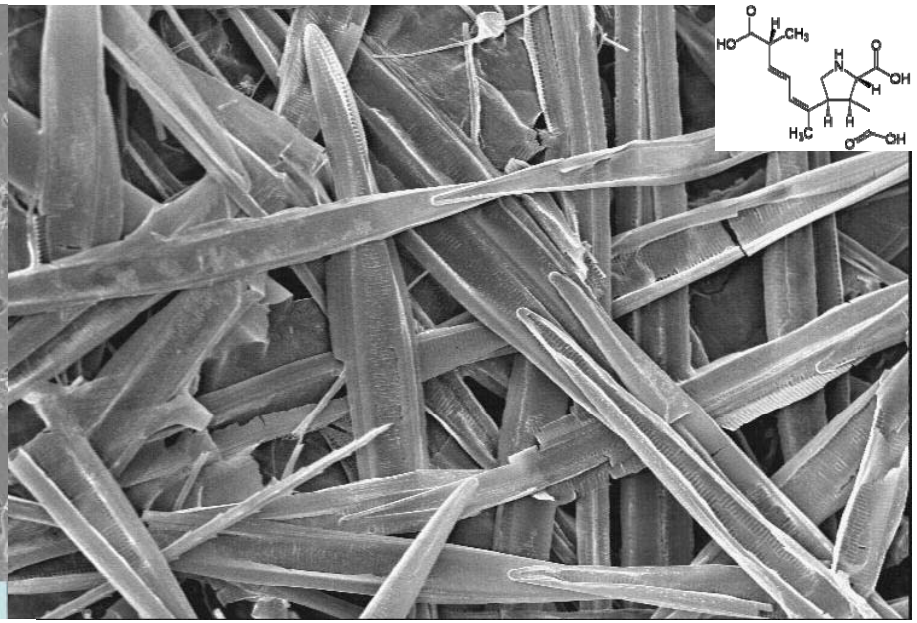
Impact on permeate quality.

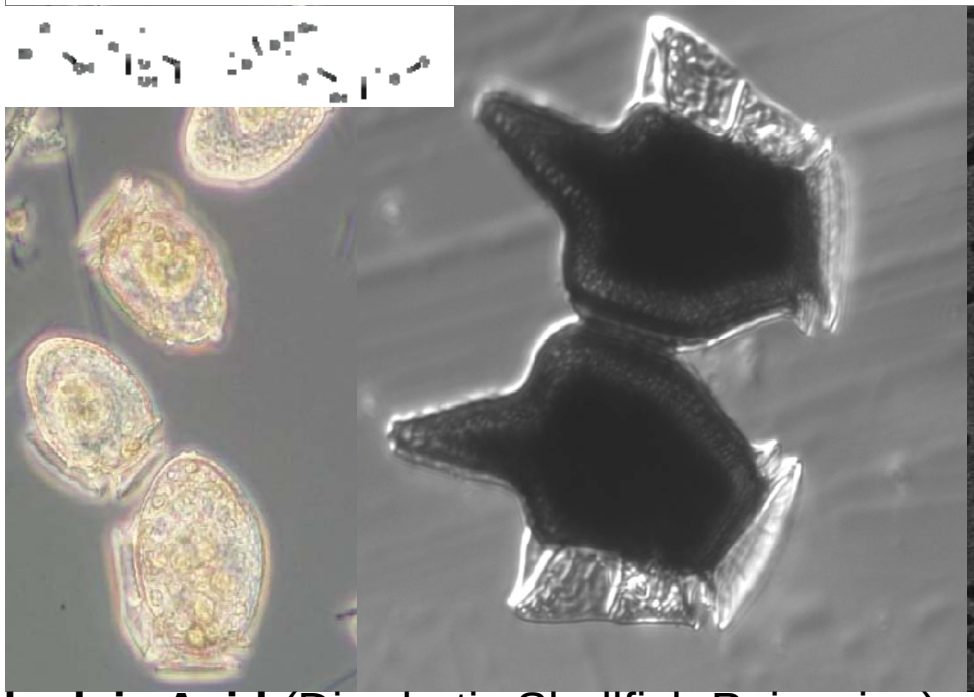
Potential increased toxicity of brine.



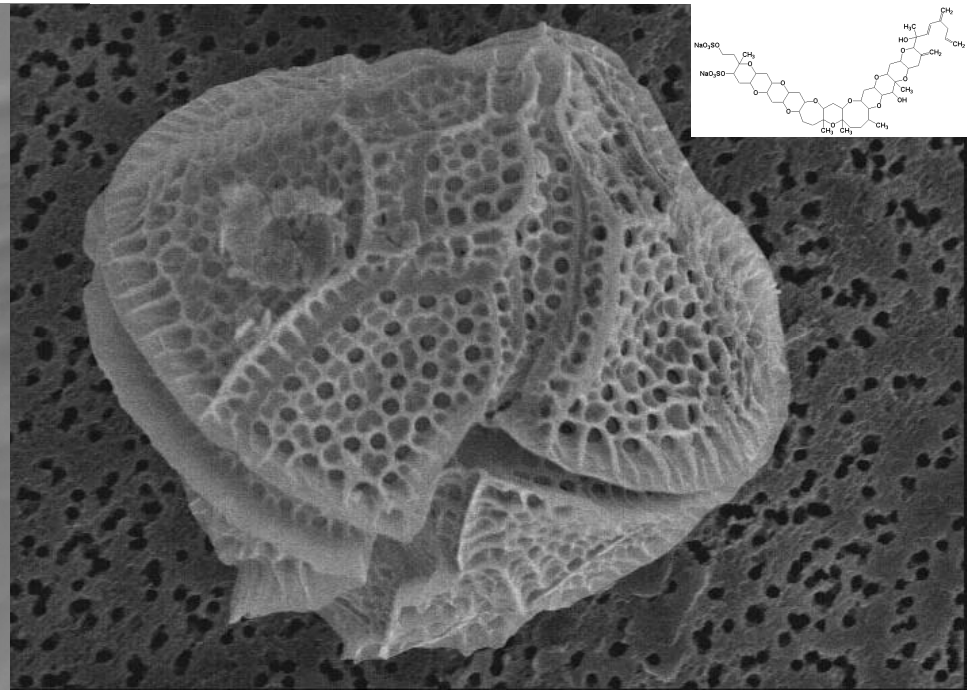
Saxitoxins (Paralytic Shellfish Poisoning)



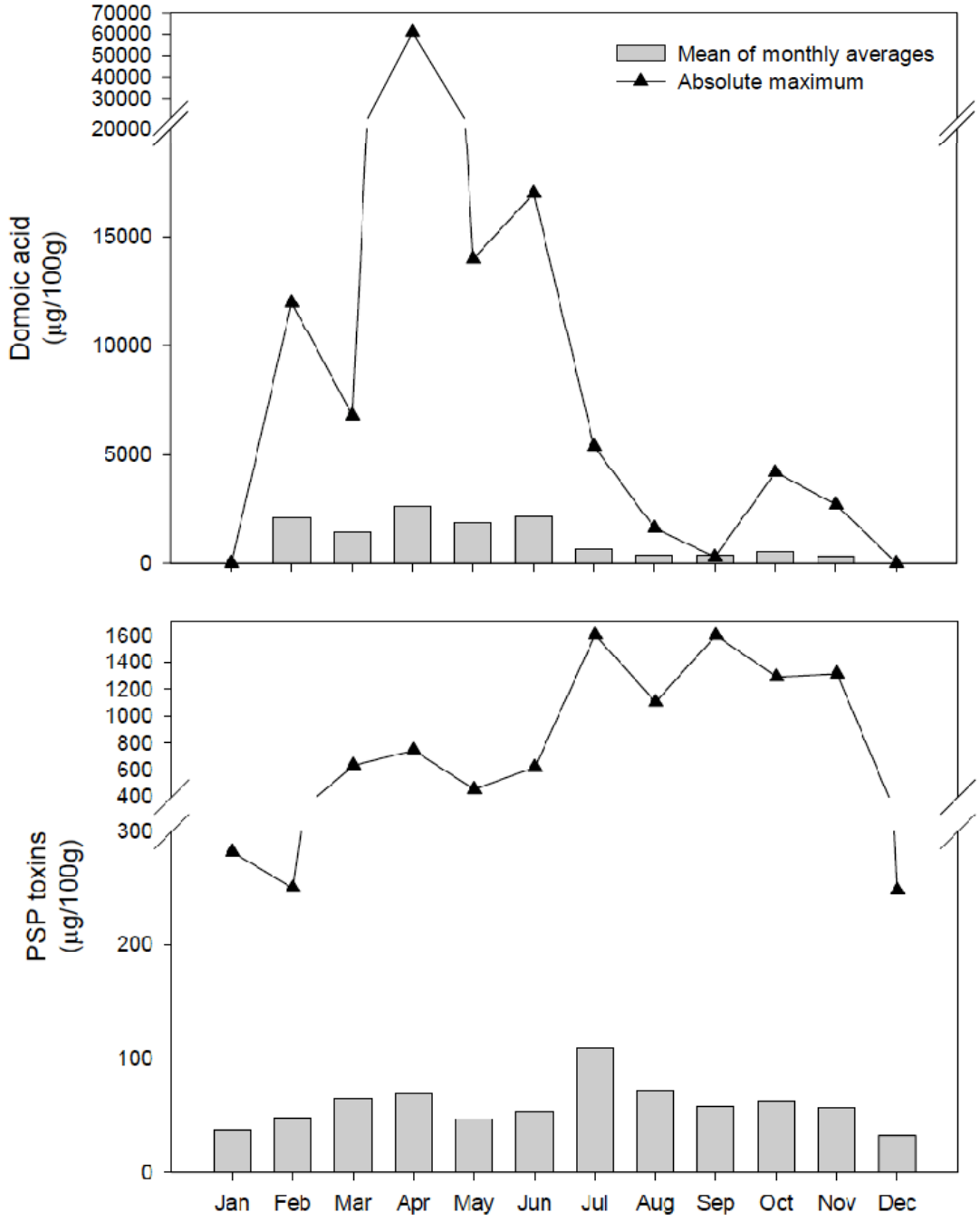
Domoic Acid (Amnesic Shellfish Poisoning)



kadaic Acid (Diarrhetic Shellfish Poisoning)

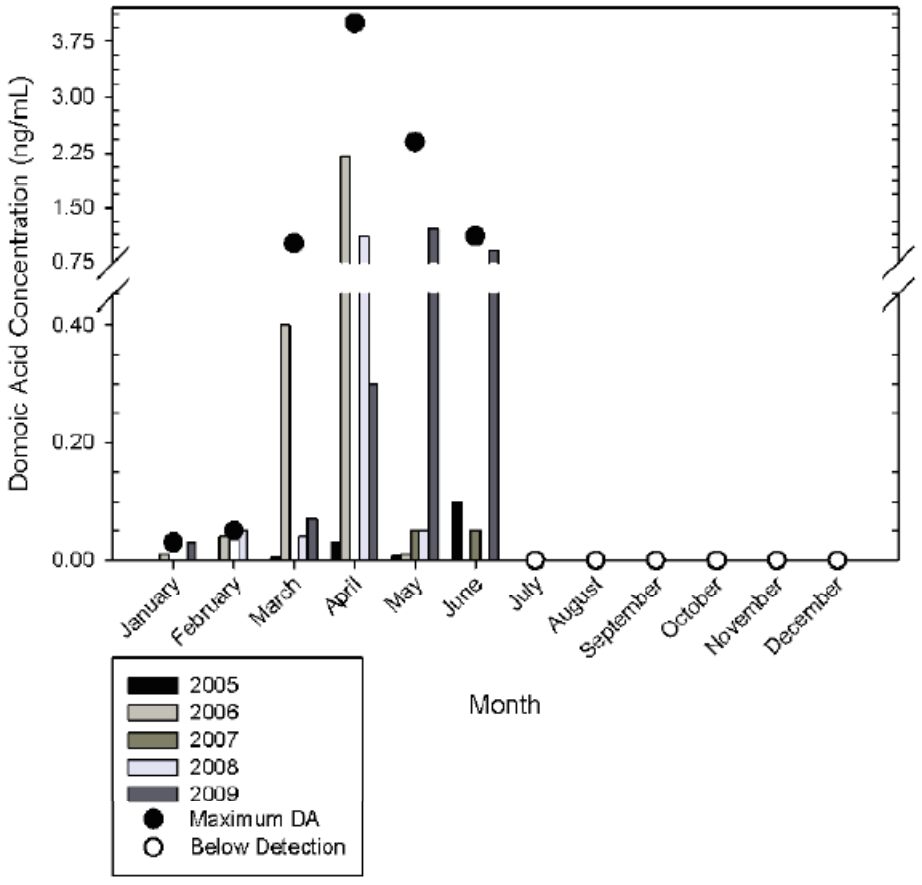


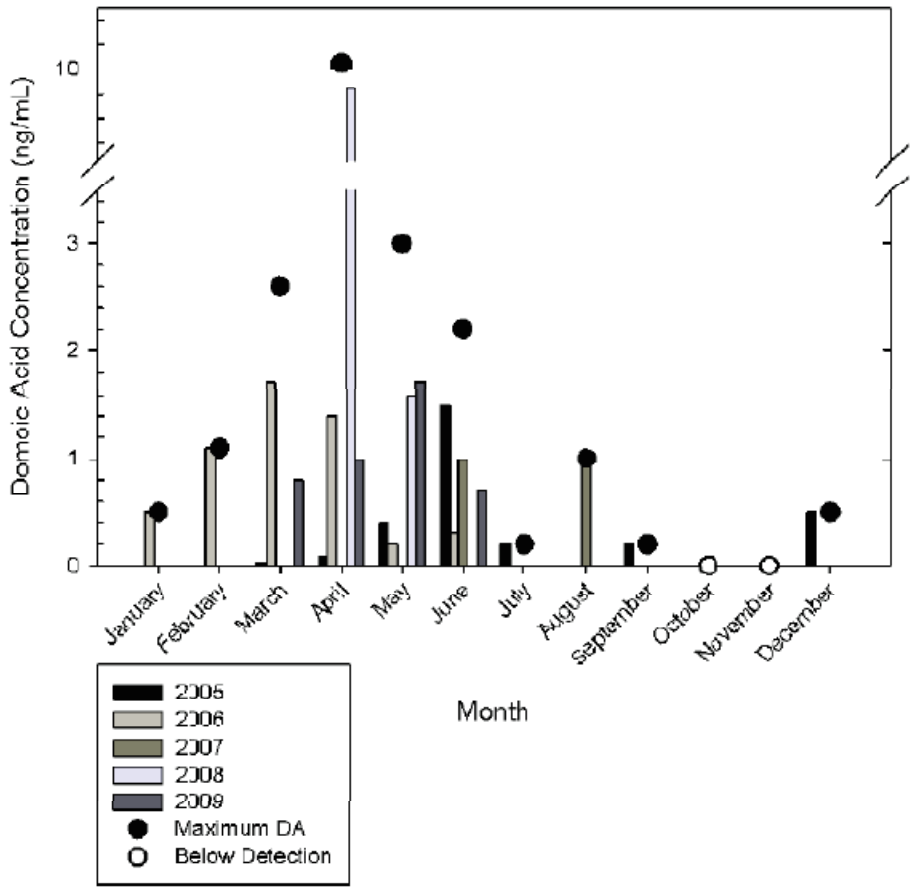
Yessotoxin



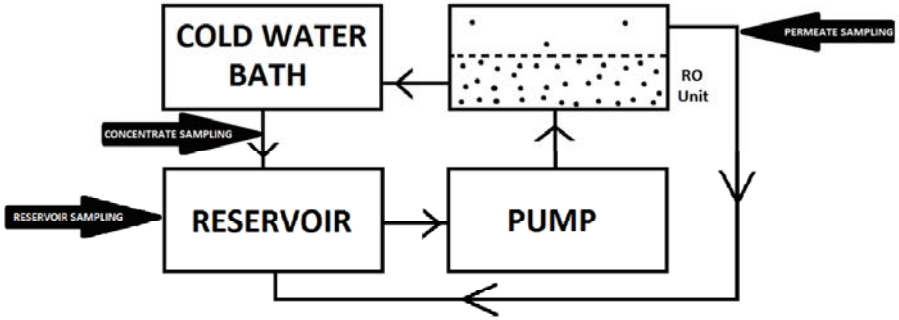
Seasonality of Domoic acid (Amnesic Shellfish Poisoning) and Saxitoxins (Paralytic Shellfish Poisoning) along the California Coast.

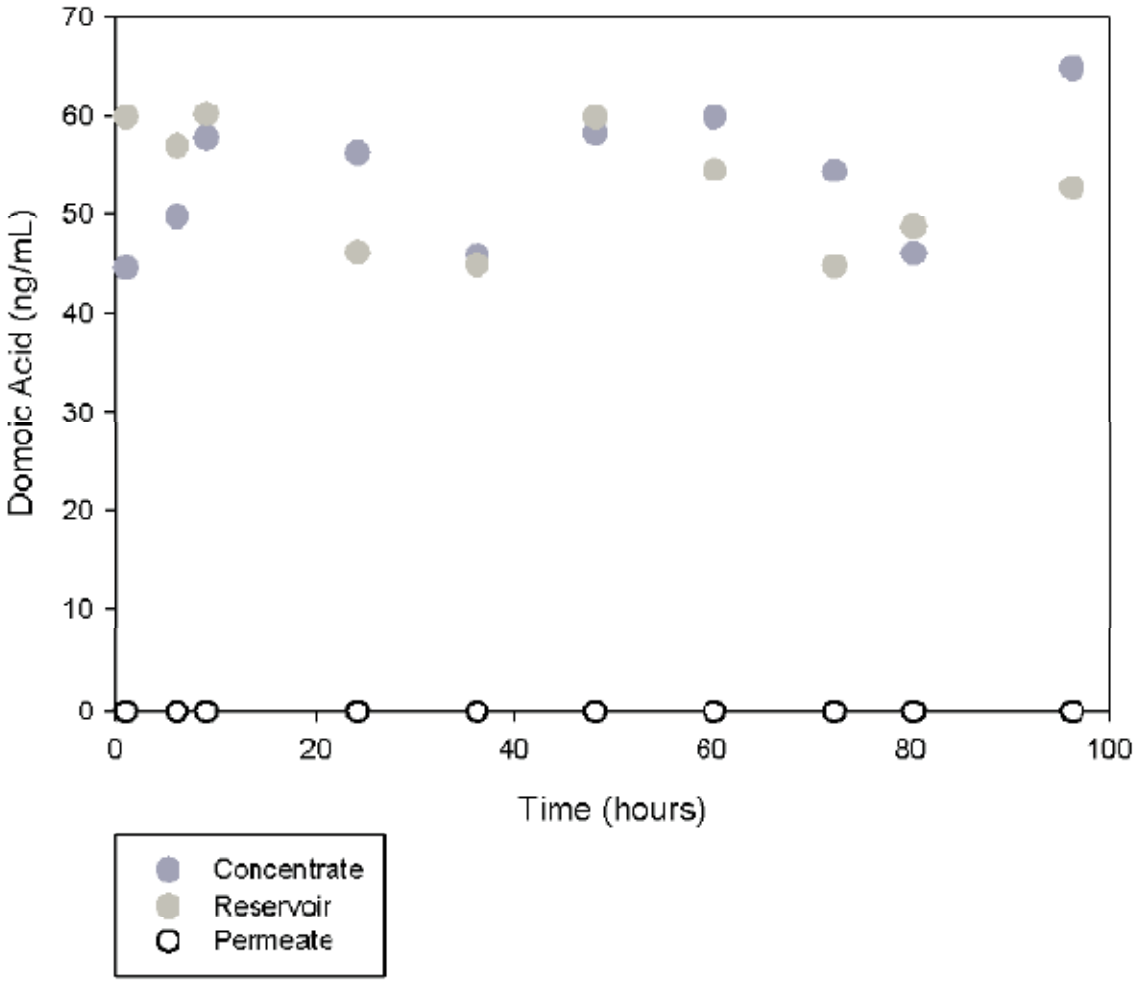
Caron et al. 2010





Seubert et al. (in prep.)





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Potential issues for RO desal

I) Massive, but relatively non-toxic blooms

Impacts on intake/desal process.

2) Toxin-producing species

Impact on permeate quality.

Potential increased toxicity of brine.

Minimal (apparent) increases in absolute concentration of toxins via RO process if brine is ≤10% increase above ambient, but increased salinity (i.e. density) could imply effective delivery to benthic biota.

Potential for:

- acute toxicity to benthic some species.
- effective bioaccumulation/contamination of benthic food web.

Domoic acid concentrations in coastal California plankton

Location and year	Causative species	Particulate $\mu g\,L^{-1}$ ($nmol\,L^{-1}$)	Cellular $pg\,cell^{-1}$	Dissolved $pg\,mL^{-1}$ ($nmol\,L^{-1}$)	References
Pt. Año Nuevo, San Francisco, CA (1998)	*P. pungens* *P. multiseries*	0.1–0.7	0.3–6.3		Trainer et al. (2000)
Bolinas Bay, San Francisco, CA (2003)	*P. australis*	0.15–9.4			Howard et al. (2007)
Monterey Bay, CA (1991, 1998)	*P. australis*	b.d.–12.3 0.1–6.7	3–37 7.2–75		Buck et al. (1992), Garrison et al. (1992), Walz et al. (1994), Scholin et al. (2000)
Monterey Bay, CA (1998)	*P. pseudodelicatissima* *P. multiseries*	0.1–0.4 0.67	0.8–1.2 6		Trainer et al. (2000, 2001)
Monterey Bay, CA (2000)	*Pseudo-nitzschia* spp. *P. australis*		b.d.–24	b.d.–8491	Bargu et al. (2002, 2008)
Monterey Bay, CA (2002–2003)	*Pseudo-nitzschia* spp.	24			Vigilant and Silver (2007)
Morro Bay, CA (1998)	*P. australis*	1.3–7.4	37–78		Trainer et al. (2000, 2001)
San Luis Obispo, CA (2003–2005)	*P. australis* *P. multiseries*	1.5–7.6	9–38		Mengelt (2006)
Point Conception, CA (1998)	*P. australis*	2.2–6.3	15–22		Trainer et al. (2000)
Santa Barbara, CA (1998)	*P. australis* *P. pungens* *P. pseudodelicatissima*	0.5–1.2	0.1–0.9		Trainer et al. (2000)
Santa Barbara Channel, CA (2003)	*P. australis*	0.03–1.7	0.14–2.1		Anderson et al. (2006)
Santa Barbara (Santa Rosa Island and north San Miguel) (2004)	*P. australis* *P. multiseries*	5–12	b.d.–80		Mengelt (2006)
Southern California Bight, CA (2003, 2004)	*Pseudo-nitzschia* spp. *P. australis* *P. cuspidata*	5.5–12.7	b.d.–117		Schnetzer et al. (2007)
San Diego and Orange counties, CA (2004)	*P. australis* *P. multiseries*	b.d.–2.33			Busse et al. (2006)

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Saxitoxin concentrations in coastal California plankton

Location and year	Causative species	Particulate $\mu g\,L^{-1}$ ($nmol\,L^{-1}$)	Cellular $pg\,cell^{-1}$	Dissolved $pg\,mL^{-1}$ ($nmol\,L^{-1}$)	References
Humboldt Bay, CA (2004)	*A. catenella*		1.6–19[a]		Jester (2008)
San Mateo County coast, CA (2004)	*A. catenella*		2.1–62.6[a]		Jester (2008)
Monterey Bay, CA (2004)	*A. catenella*		0.6–31.3[a]		Jester (2008)
Monterey Bay, CA (2003–2005)	*A. catenella*	b.d.–0.962			Jester et al. (2009b)
Morro Bay, CA (2004)	*A. catenella*		1.4–16.6[a]		Jester (2008)

Yessotoxin concentrations in coastal California plankton

La Jolla, CA (1993)	*Lingulodinium polyedrum*	0.002–0.02[a] 0–0.05[a]	Armstrong and Kudela (2006) Howard et al. (2008)

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