Salt-marsh drainage, acid sulfate soils, nuisance mosquito production and Herring River tidal restoration

Salt-marsh drainage and resulting acidification of surface water and loss of aquatic fauna is widespread throughout the world:

Sammut, J. and MD Melville & GC Fraser. 1995. Estuarine acidification: impacts on aquatic biota of draining acid sulfate soils. Australian Geographical Studies. 33:89-100.

Detailed description of acid- and aluminum-induced fish disease.

The problem has been severe in Herring River:

Soukup, M. A. and J. W. Portnoy. 1986. Impacts from mosquito control-induced sulphur mobilization in a Cape Cod Estuary. Environmental Conservation 13(1):47-50.

Portnoy, J.W. 1984. Salt marsh diking and nuisance mosquito production on Cape Cod, Massachusetts. J. Amer. Mosq. Cont. Assoc. 44:560-564.

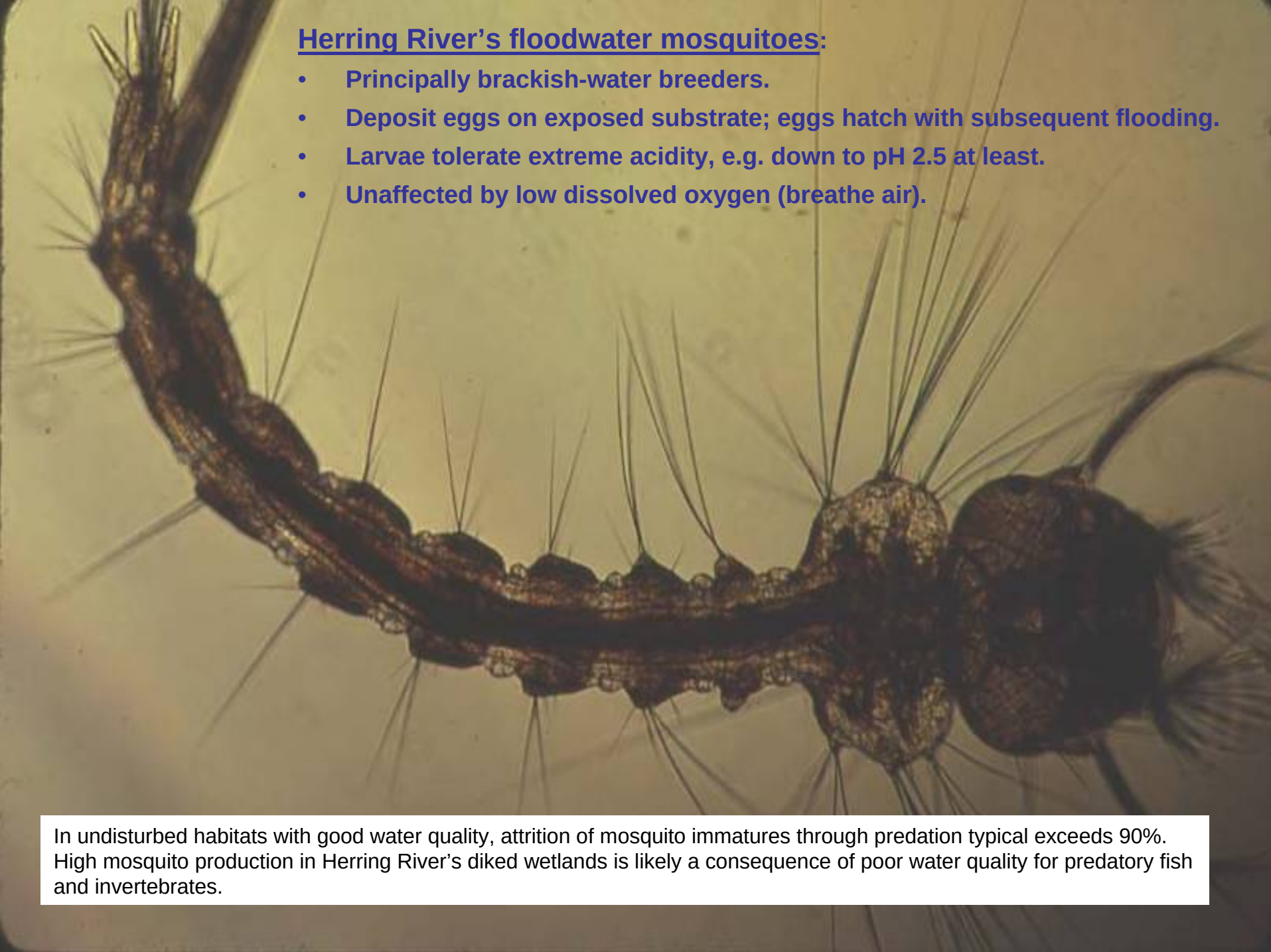
Brackish-water-breeding mosquitoes breed successfully and abundantly in Herring River flood plain where diking and drainage have acidified surface waters, mobilized aluminum and eliminated predatory fish.

Tidal restoration has been shown to restore water quality, fish, and their control of mosquito larvae:

Easton, C.& A. Marshall. 2000. Control of acidic drain-water-breeding mosquitoes in New South Wales, Australia, by installing controlled leakage holes in tidal flap gates. J. Amer Mosq. Control Assoc. 16:19-21.

Before tide restoration surface water had pH as low as 2.7, conditions that were toxic to fish and continually held mosquito larvae.

Four weeks after tidal restoration, water pH had recovered and mosquito larvae decreased 99.98%.

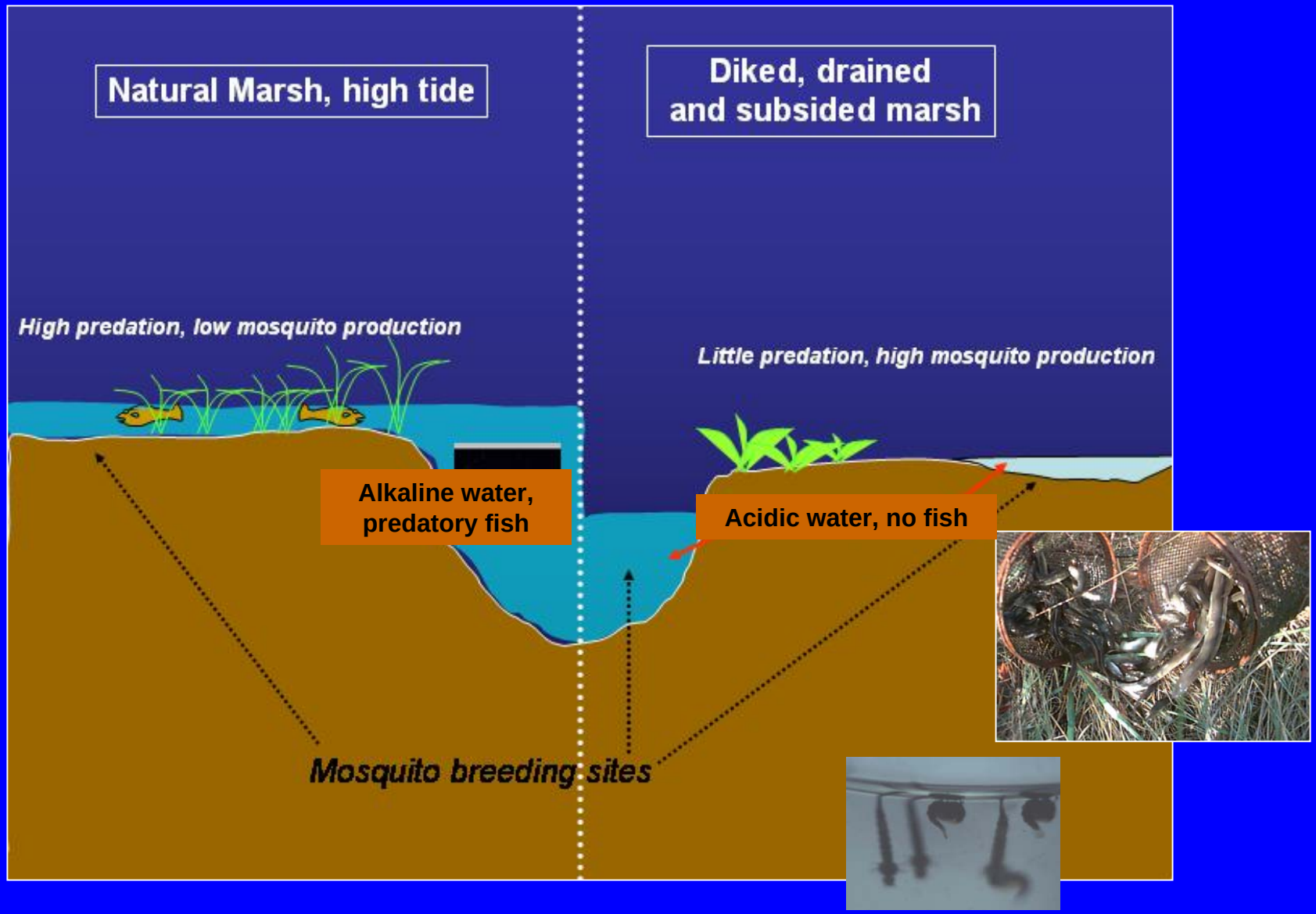


Herring River's floodwater mosquitoes:

- **Principally brackish-water breeders.**
- **Deposit eggs on exposed substrate; eggs hatch with subsequent flooding.**
- **Larvae tolerate extreme acidity, e.g. down to pH 2.5 at least.**
- **Unaffected by low dissolved oxygen (breathe air).**

In undisturbed habitats with good water quality, attrition of mosquito immatures through predation typical exceeds 90%. High mosquito production in Herring River's diked wetlands is likely a consequence of poor water quality for predatory fish and invertebrates.

Fish Kills and Mosquito Production

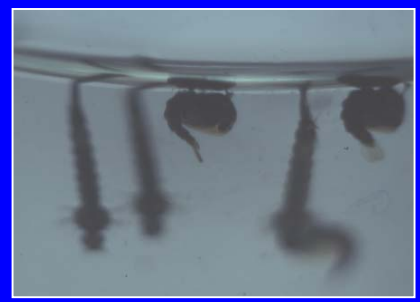


Degraded Herring River water quality, caused by inappropriate water management in the past, has indirectly led to high mosquito production by limiting fish predators. The fish fauna above the dike are low in both numbers and diversity; also, the diking prevents tides from flushing out, and providing fish access to, mosquito breeding sites on the marsh surface.

From the 1920s until the early 1980s, the Herring River was repeatedly channelized to increase drainage.

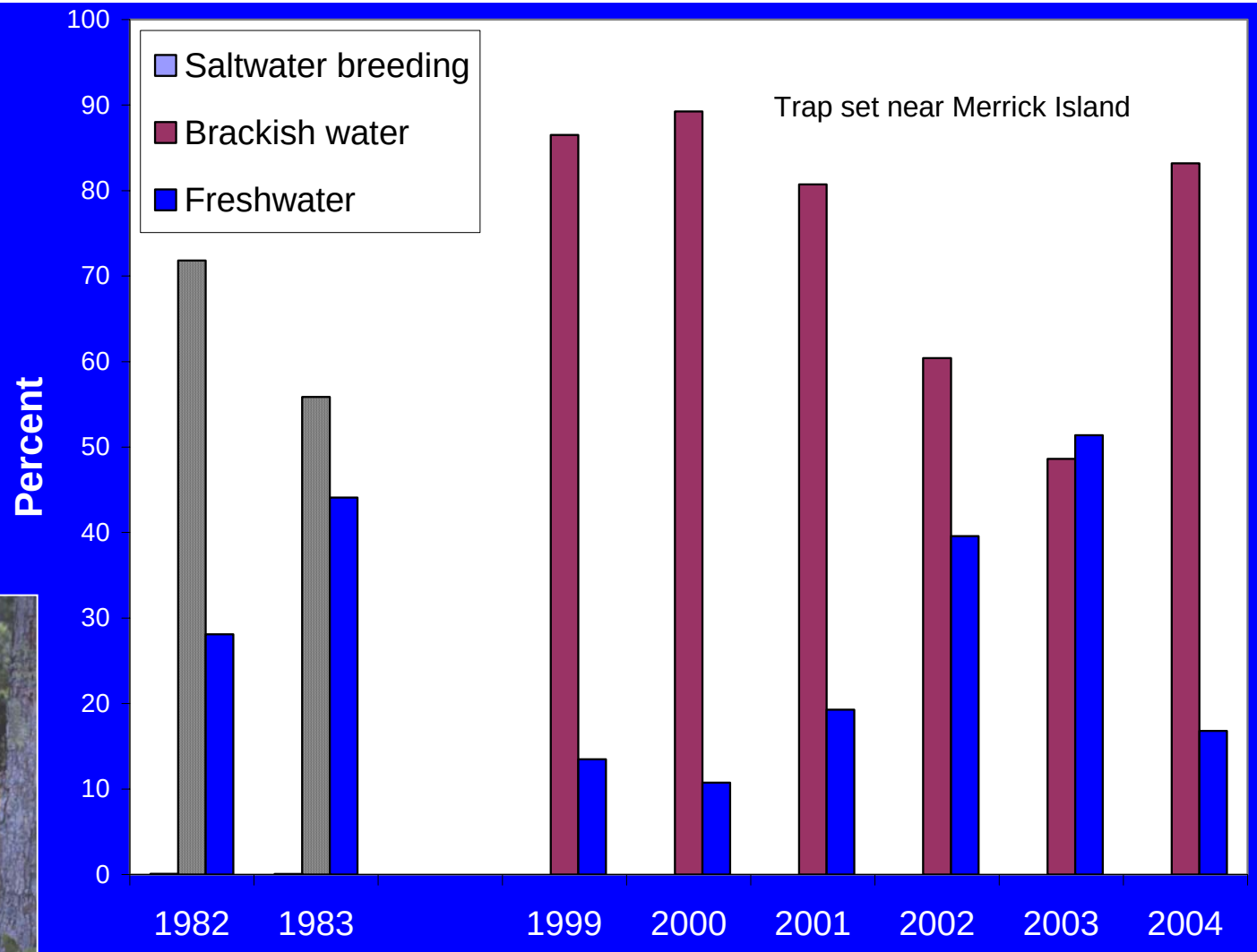
As a result, pyrite-rich sediment was exposed to air both in spoil piles and in the drained marsh itself, leading to the release of sulfuric acid into remaining surface waters, and killing or excluding fish.

Despite effective wetland drainage, in the absence of predatory fish mosquito production remained high.



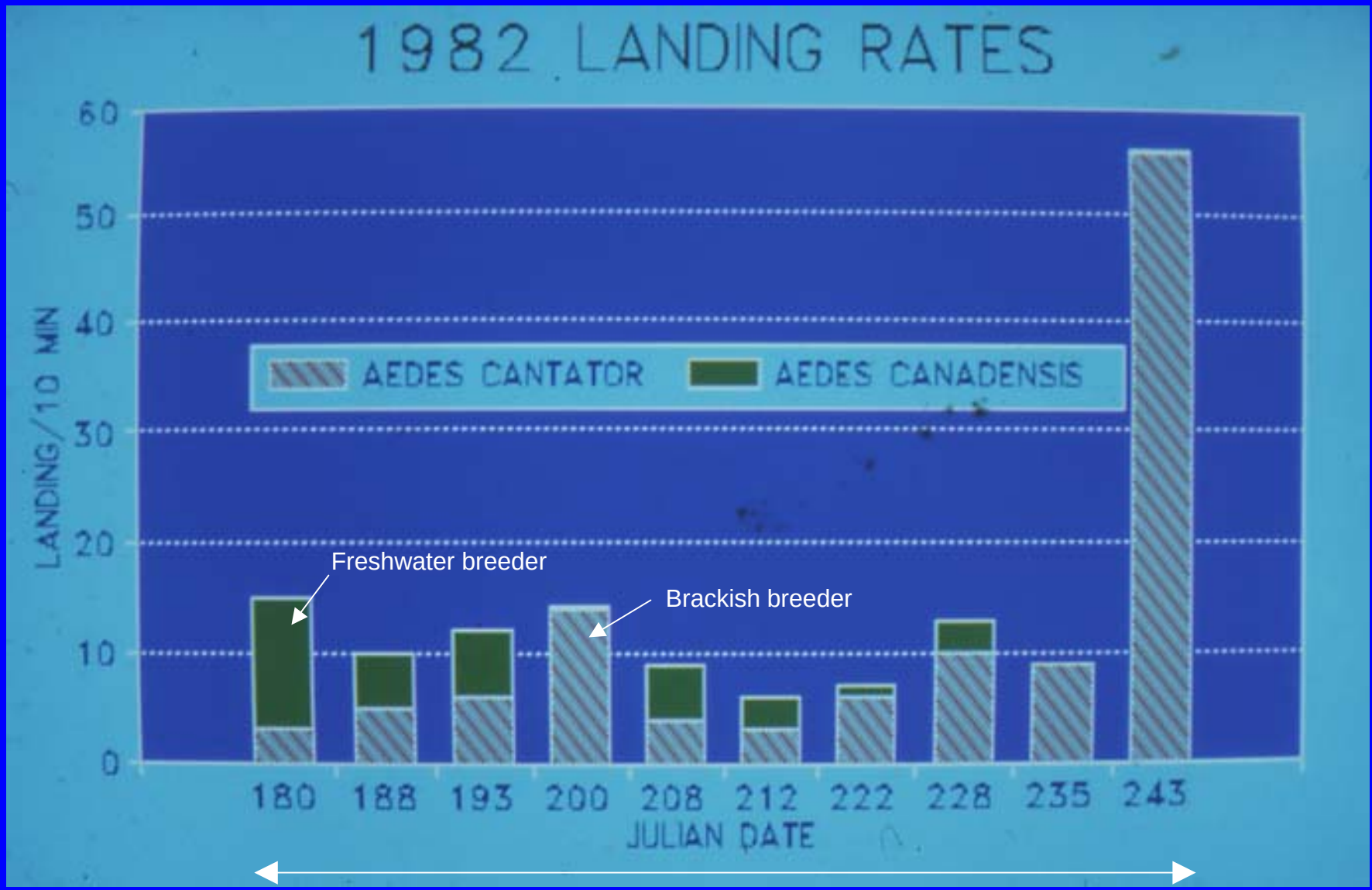
Current species composition of adult mosquitoes near Herring River.
The brackish-water breeders, which nearly always predominate, prefer to lay their eggs in high-sulfate waters; aquatic larvae tolerate extreme acidity.

Trap for adult mosquitoes.



1999-2004 data courtesy Cape Cod Mosquito Control Project

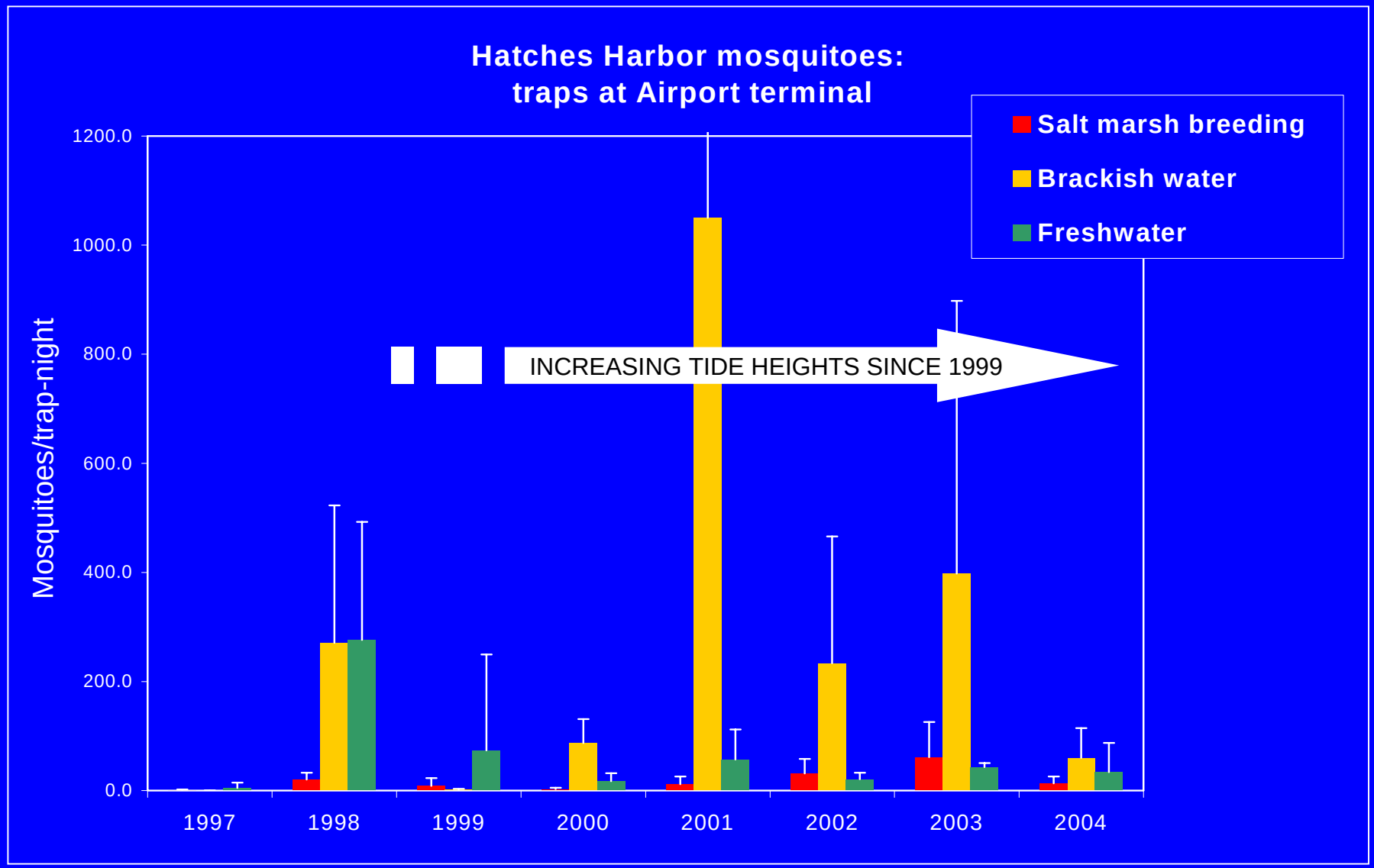
Bottom line: what's biting me?



Past studies have used mosquito landing rates, on an exposed forearm, to assess the nuisance to people. The brackish-water breeding *Aedes* (now *Ochlerotatus*) *cantator* has usually been dominant.

Will species composition of nuisance mosquitoes change with restored tidal flooding?

Tidal restoration at Hatches Harbor has not been followed by a significant increase in saltwater-breeding mosquitoes; nor has the overall mosquito nuisance increased substantially?



Creek restoration at Hatches Harbor

In 2004, the Cape Cod Mosquito Control Project, in cooperation with the NPS, used a rotary ditcher to re-establish portions of Race Run, which had become filled with sediment due to the lack of tidal flushing since diking in 1930. Benefits include restored tidal flushing and increased fish access of the marsh surface, both favoring mosquito control, and increased penetration of seawater, suppressing exotic *Phragmites* and allowing recolonization by salt-marsh plants.