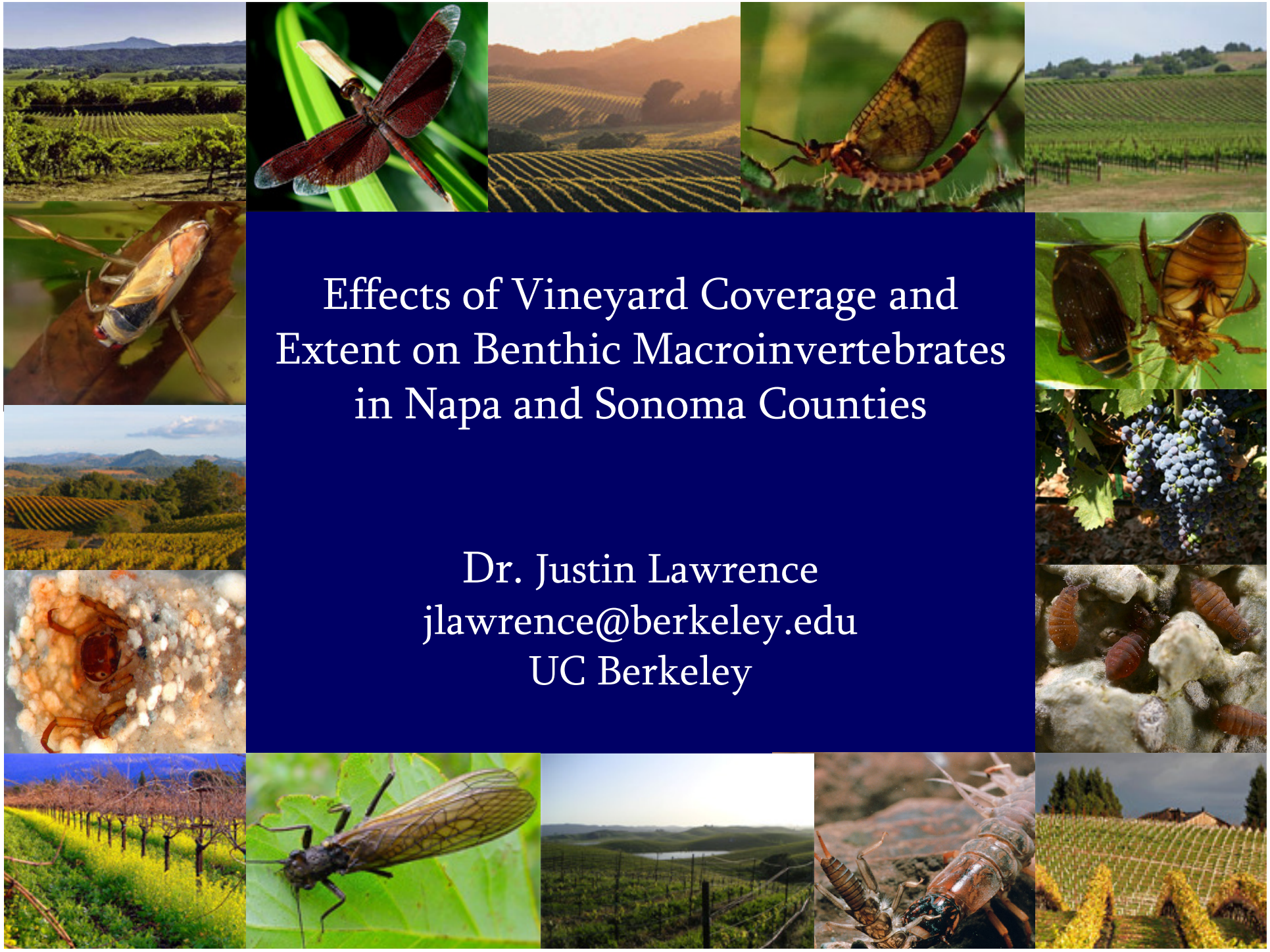


Effects of Vineyard Coverage and Extent on Benthic Macroinvertebrates in Napa and Sonoma Counties

Dr. Justin Lawrence
jlawrence@berkeley.edu
UC Berkeley

Outline

1. Study objectives
2. Introduction
3. Methods
4. Results
5. Conclusions

Study objectives

To determine whether:

1) vineyard water-withdrawals for frost protection affect benthic-macroinvertebrates
2) there is a level of vineyard coverage above which the effects are more pronounced
3) exceeding this level has any effect on *a priori* selected biological traits

Vineyards are a dominant feature of many landscapes in Mediterranean-climate regions

Chile

South Africa

Spain

Australia

California

Vines are susceptible to frost damage

- Low temperature injuries typically occur during the spring months when air temperatures drop below ~ 0.5˚C.

Kasimatis & Kissler, 1974, *Am. J. Enol. Vitic.*

Bud break in Sonoma County

Vineyards use different methods of frost protection

- Vineyard site selection
- Grape variety selection
- Cultural practices
- Wind circulation
- Heaters
- Water sprinklers

Kasimatis & Kissler. 1974, *Am. J. Enol. Vitic.*
Johnson & Howell. 1981, *Am. J. Enol. Vitic.*
Donaldson *et al.* 1993, *Am. J. Enol. Vitic.*

Water sprinklers and their environmental effects

- Water sprinklers, which often use groundwater, are used on ~ 9% of the total irrigated vineyard-land in California.

  Orang *et al.* 2008, *J. Irrig. Drain. Eng.*

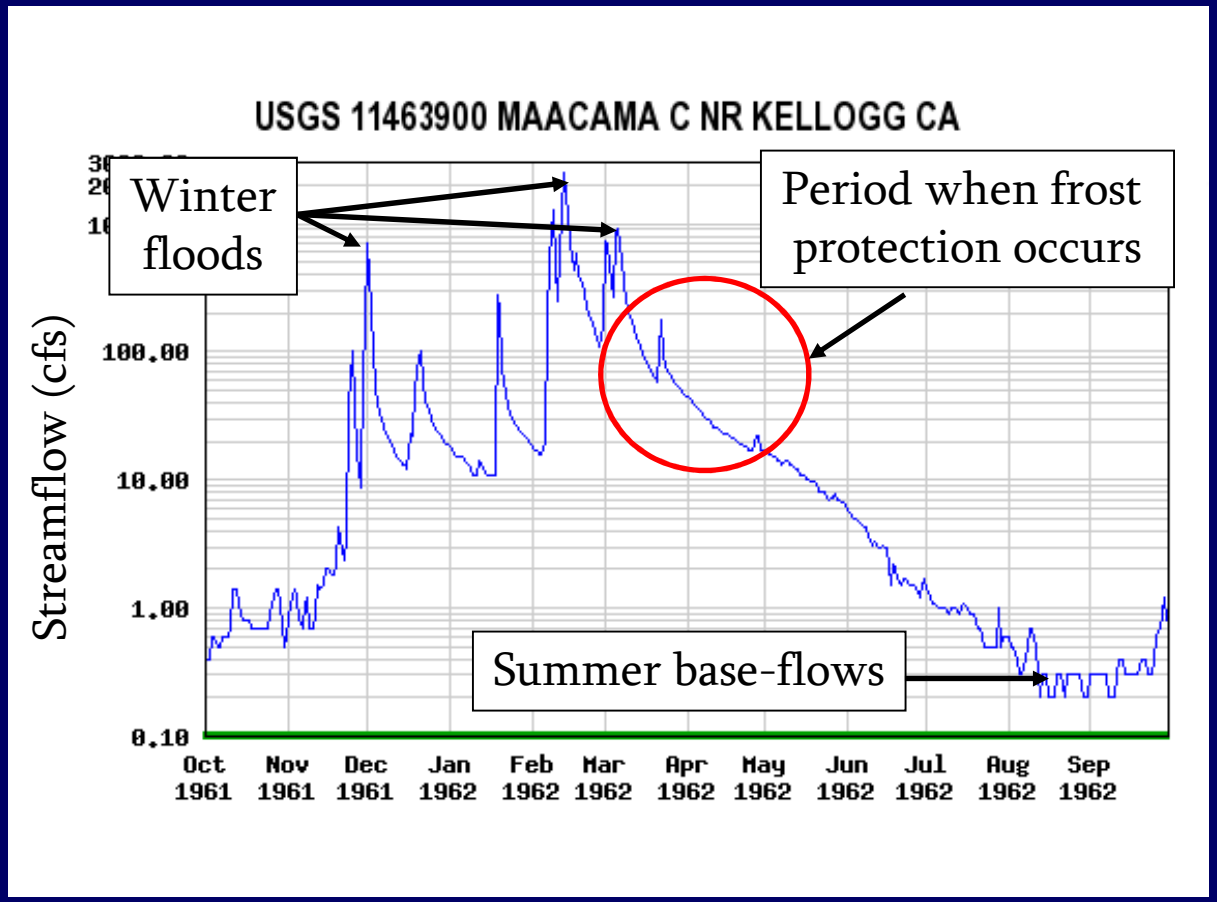
- Use of water sprinklers for frost protection has been observed repeatedly to drastically reduce streamflow.

  Deitch *et al.* 2009, *River Res. Applic.*

- These streamflow reductions typically occur between March and April, which is a very important time period for growth and reproduction of benthic macroinvertebrates.

  Mendez & Resh 2008, *Ann. Entomol. Soc. Am.*

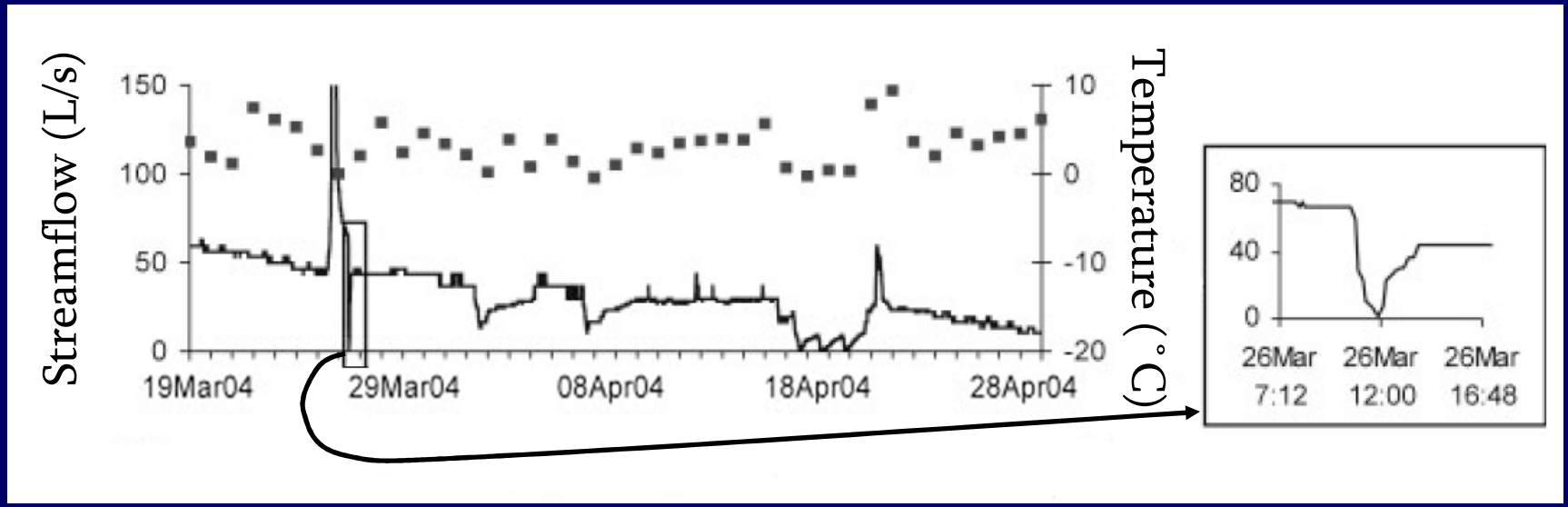
The annual hydrograph of mediterranean-climate streams



http://waterdata.usgs.gov/

Streamflow reductions correlated with low temperatures

Franz Creek, Sonoma County, 2004



Deitch *et al.* 2009, *River Res. Applic.*

Macroinvertebrate responses to streamflow reductions

- Macroinverterbate responses to vineyard water-withdrawals for frost protection have not been previously examined.

- However, many studies have observed a macroinvertebrate response to streamflow reductions (e.g. from drought) in mediterranean-climate regions similar to Napa and Sonoma.

Bonada *et al.* 2006, *J. N. Am. Benthol. Soc.;*
Bonada *et al.* 2007, *Hydrobiologia;*
Tornés *et al.* 2007, *Ann. Limnol. – Int. J. Lim.;*
Morais 2008, *Ann. Limnol. – Int. J. Lim.*

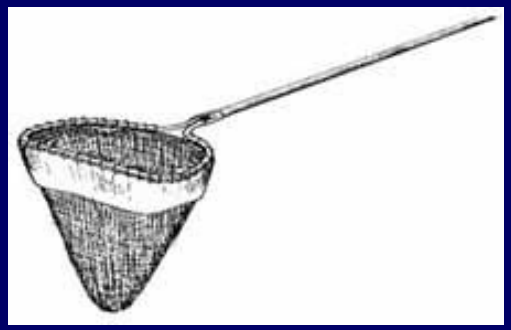
Methods

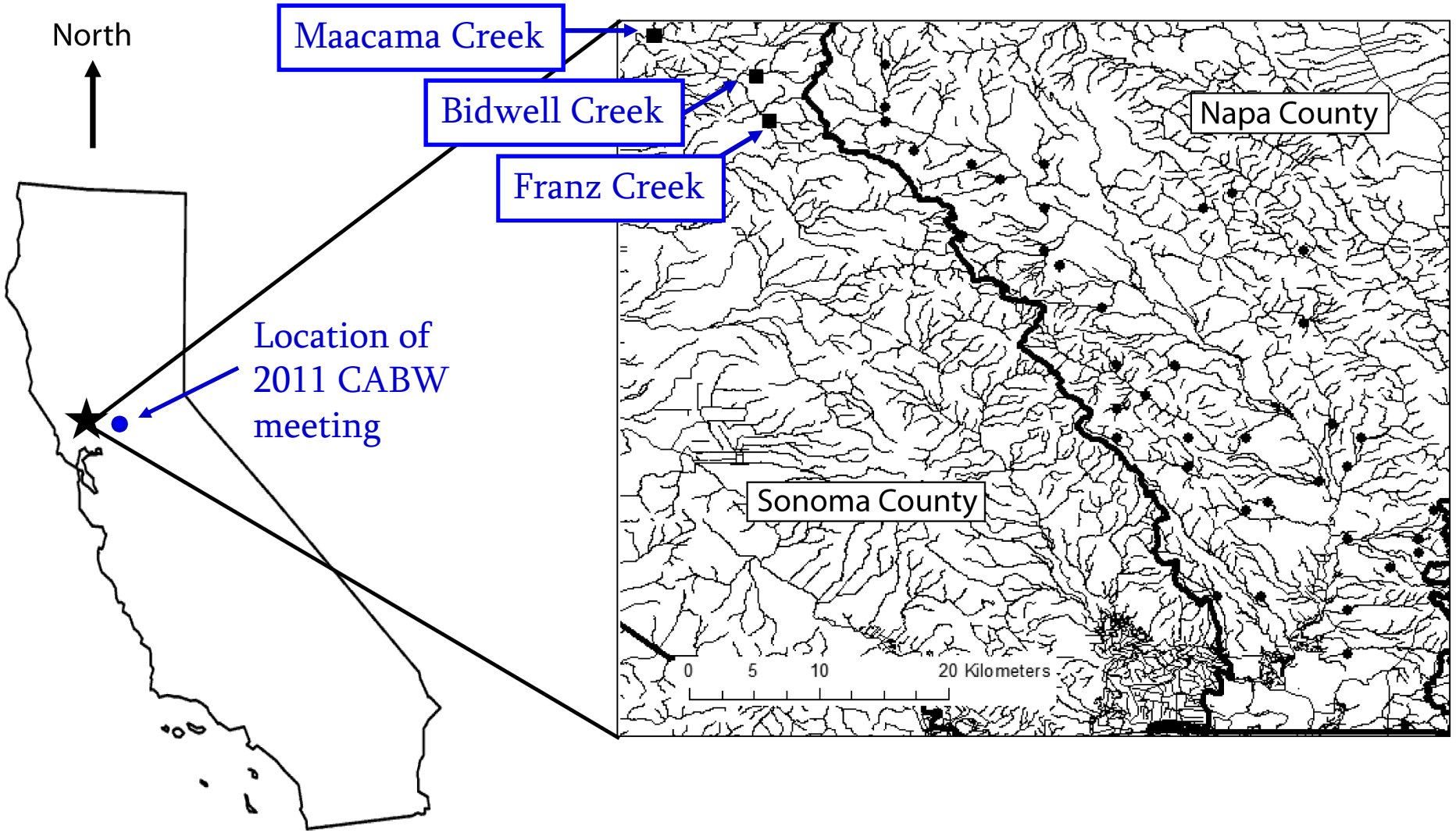
- Analyzed two benthic-macroinvertebrate datasets collected from the major wine-growing region of Northern California.
- The first includes samples collected intensively over time (2004-'05) in three small streams in Sonoma County from just-before to just-after the vineyard frost-protection period.
- The second includes samples collected intensively over space in Napa County (2000-'01), including 39 sites on 35 streams.

Collection techniques

- First dataset – One D-frame kick-net sample (500 μm mesh) collected from a single riffle at each site at ~2 week intervals from early March to early May each year.

- Second dataset – Collections were made following the standard, targeted-riffle approach of the SWAMP protocol.





Lawrence *et al.*, In press. *Ann. Limnol. – Int. J. Lim.*

The three-site study

Franz Creek was heavily impacted by water withdrawals for frost protection, whereas the other two sites examined were not.

Site	Number of drying events	Median reduction of flow, percent	Lower quartile of flow reduction, percent	Upper quartile of flow reduction, percent
Franz	7	78	45	80
Bidwell	5	15	12	24
Maacama	3	0	0	0

Adapted from Deitch *et al.* 2009, *River Res. Applic.*

Evaluating the effects of vineyard water-withdrawals for frost protection

- Calculated 5 metrics from the macroinvertebrate data
  - 1) North Coast B-IBI
  - 2) Total taxa richness
  - 3) Total abundance
  - 4) % EPT
  - 5) EPT/OCH richness




- Compared values from a single sampling event just before frost-protection withdrawals occurred to just after they ended, and examined the change separately for each year.

Determining if there was a level of vineyard coverage above which the effects are more pronounced

- Calculated B-IBI values for all sampling events and examined the values across the range of vineyard coverages observed.
- Plotted the B-IBI values against % vineyard-coverage to examine possible changes that occur above a certain coverage.
- Then compared average values of the B-IBI and its component metrics below and above this coverage level.

Vineyard coverage and biological traits

- Three trait categories hypothesized *a priori* to be most likely to show an impact were chosen for analysis (presence of a semivoltine life-cycle, diapause, and burrowing ability).

- Distribution of traits among taxa was calculated from abundance data and a traits database developed for this region.

Bêche et al. 2006, *Freshw. Biol.*

Results – The three-site study

- A decrease was observed in the value of the North Coast B-IBI and in EPT/OCH individuals in Franz Creek in both years.

- In the other sites examined, either an increase was observed or there were no consistent trends.

Site	Metric	2004		2005		Trend
		Pre-Withdrawal	Post-Withdrawal	Pre-Withdrawal	Post-Withdrawal	
Franz Creek	North Coast B-IBI	48	40	42	32	Decrease
	EPT / OCH Individuals	30	4	32	8	Decrease
Bidwell Creek	North Coast B-IBI	39	46	23	29	Increase
	EPT / OCH Individuals	66	9.5	42	77	Unclear
Maacama Creek	North Coast B-IBI	41	45	34	29	Unclear
	EPT / OCH Individuals	26	4.4	3	7	Unclear

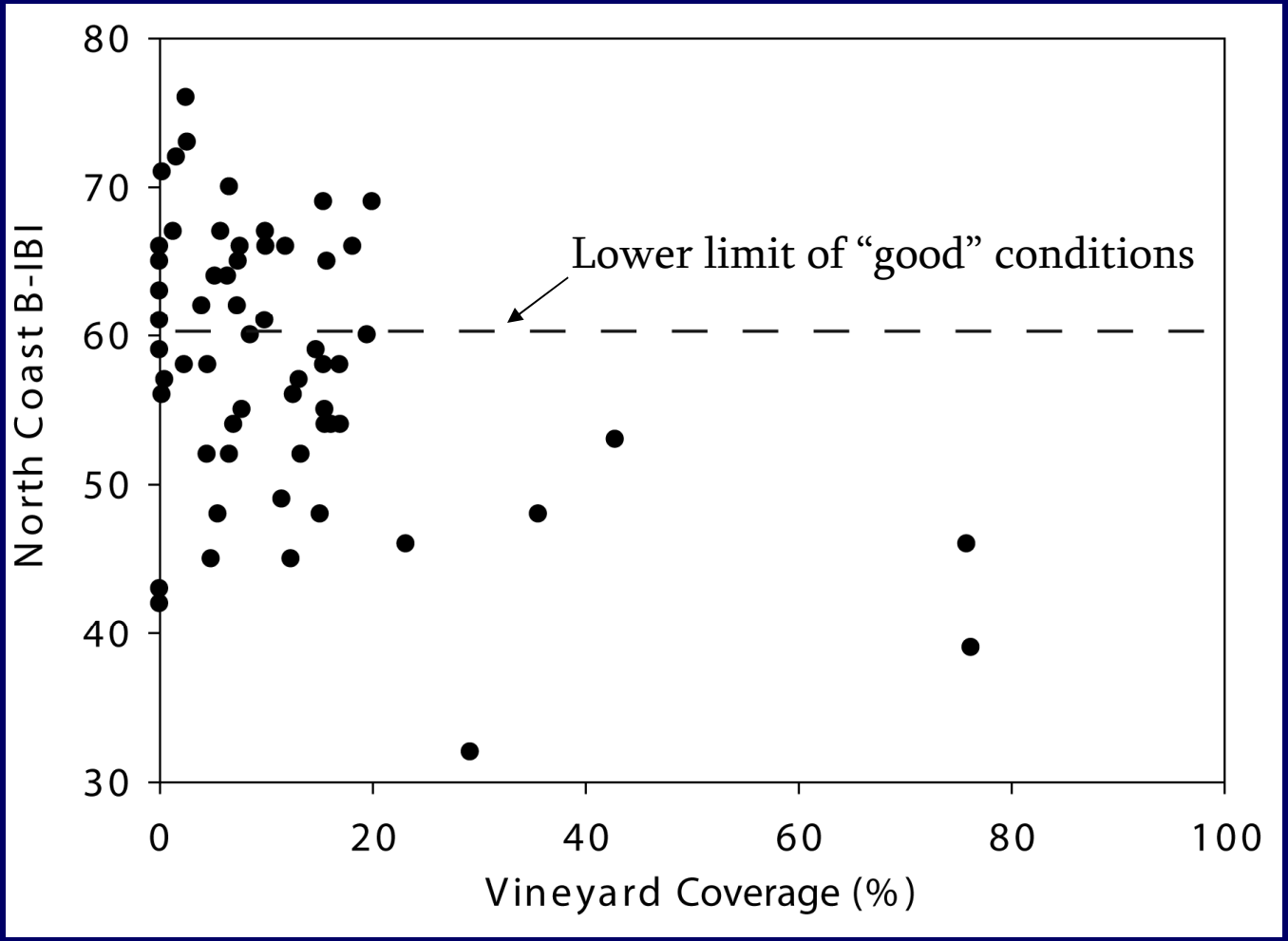
Genera that disappeared or were strongly reduced in density in Franz Creek and that resisted in the other two sites included *Drunella*, *Epeorus*, and *Gumaga*.

Drunella
(Ephemeroptera: Ephemerellidae)

Epeorus
(Ephemeroptera: Heptageniidae)

Gumaga
(Trichoptera: Sericostomatidae)

Results – The 39-site study

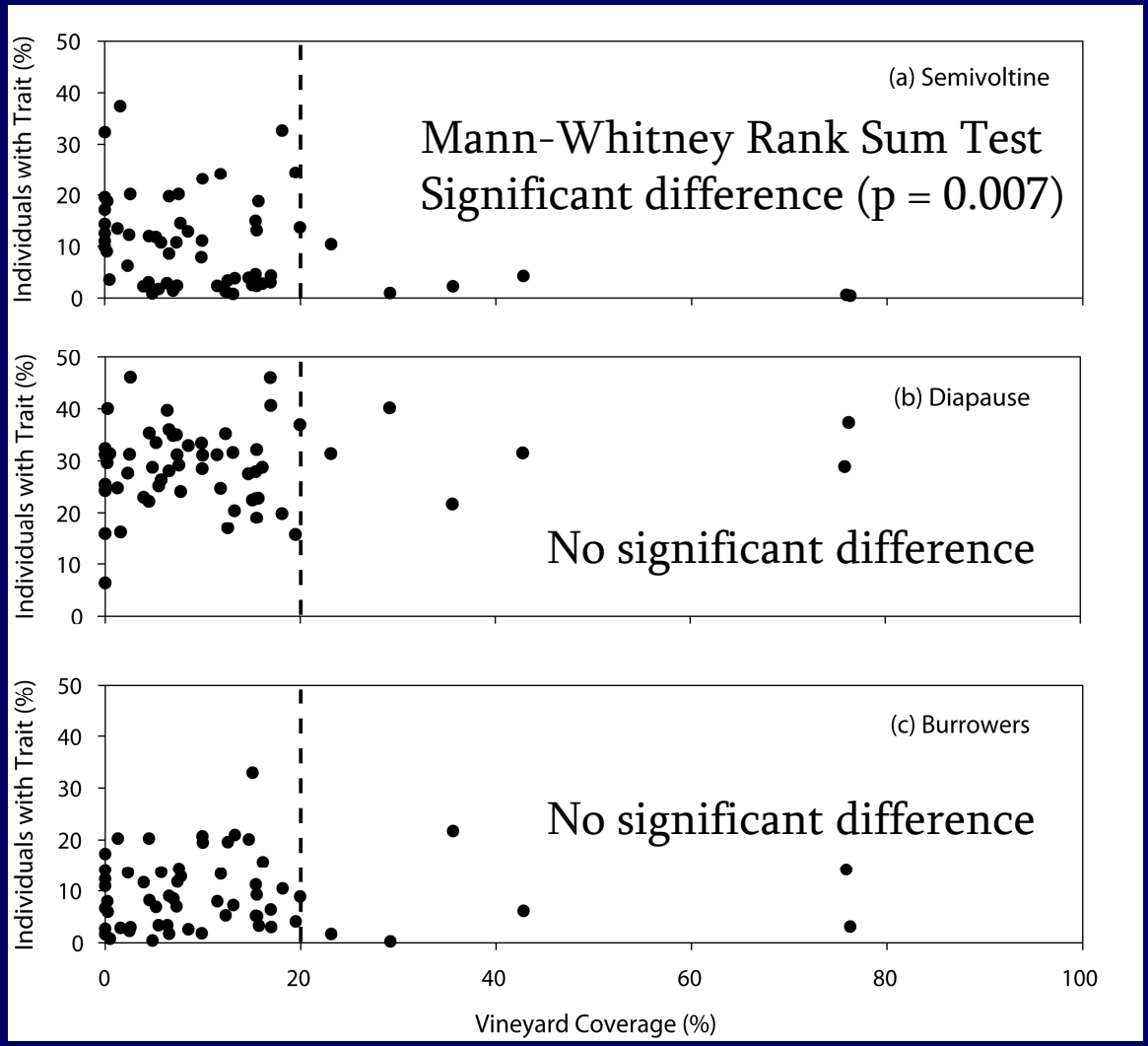


Lawrence *et al.*, In press. *Ann. Limnol. – Int. J. Lim.*

The 20% vineyard-coverage level

- The difference in the average value of the B-IBI below and above 20% coverage was statistically significant ($p<0.001$).
- Six of the eight component metrics of the B-IBI indicated a significant difference below and above 20% coverage.

Lower % of semivoltine individuals observed above 20% coverage, but no trends observed for other traits examined.



Conclusions

- The effects observed in Franz Creek were likely related to frost protection because they were not observed in the nearby creeks examined without frost-protection influence.

- Above a 20% vineyard-coverage level in Napa and Sonoma counties, a strong effect can be expected on benthic-macroinvertebrate communities.

Thanks!

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