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Long-term macroinvertebrate responses to climate change: Implications for biological assessment in Mediterranean-climate streams

Justin E. Lawrence, Kevin B. Lunde, Raphael D. Mazor, Leah A. Bêche, Eric P. McElravy and Vincent H. Resh

ABSTRACT

Climate change is expected to have strong effects on Mediterranean-climate regions (MCRs) worldwide, including increases in temperature and decreases in rainfall in some areas, which could have important implications for biological assessment programs of aquatic ecosystems. We examined potential climate-change effects on aquatic communities using a consistently collected, 20-year benthic macroinvertebrate dataset from 4 sites along 2 small northern California streams. The sites represented unique combinations of stream order and flow intermittency. We found that the benthic macroinvertebrate index of biotic integrity (B-IBI) developed for northern California streams was not influenced by temperature extremes (cool and warm) or precipitation extremes (wet and dry). Likewise, other common indices and metrics used in biological monitoring studies, such as the ratio of observed to expected taxa (O/E), percent Ephemeroptera, Plecoptera, and Trichoptera (EPT) individuals, and total richness were unaffected by temperature and precipitation variability. For future monitoring of climate-change effects on small streams, we developed a local climate-change indicator that is composed of the presence/absence of nine macroinvertebrate taxa, identified to genus level. This indicator was successful in detecting significant differences between years that were grouped based on temperature, precipitation, and a combination of temperature and precipitation. It was also successful in detecting significant differences between groups in an external dataset including 40 reference sites throughout the San Francisco Bay Area, which suggests that this indicator could be useful at larger spatial scales in this region. In addition, we found that two biological trait categories found in large, long-lived organisms decreased with increasing temperature and decreasing precipitation at the most intermittent site, indicating that climate change may selectively affect taxa with certain traits. The robustness of the B-IBI for northern California and other common indices and metrics to temperature and precipitation variability demonstrates their continued applicability for examining water quality under future climate change scenarios. However, it also suggests that they likely will not be good indicators for detecting climate-change effects. The impacts of climate change in Mediterranean-climate streams can be effectively monitored within the framework of existing biological assessment programs by using regional indicators based on specific taxa identified to the generic level and information on their species traits.

Full Text

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