Technical Report 0643

Evaluation of Stream Condition Indicators for Determining Effects of Direct Hydromodification via Stream Bank Armoring

Eric D. Stein[1], Matthew Cover[2], Clare O'Reilly[3], James J. Hayes[4], A. Elizabeth Fetscher[1], Richard Ambrose[5], Lisa S. Fong[5], Roxana Guardado[2], Christopher Solek[1], G. Matthias Kondolf[3], Chris Alford[3] and Carolina Zuri[3]

[1]*Southern California Coastal Water Research Project*

[2]*California State University, Stanislaus*

[3]*University of California, Berkeley*

[4]*California State University, Northridge*

[5]*University of California, Los Angeles*

EXECUTIVE SUMMARY

Localized armoring of stream channels is a common management response to a real or perceived threat to adjacent infrastructure or development from flooding or bank erosion. In many rural and suburban areas, short segments of channels may be armored with rock or concrete to direct flow away from roads, pipelines, or developed areas or to protect adjacent areas from the effects of overbank flow and/or channel migration. Despite their pervasiveness, the effects of reach-scale channel armoring have received less attention than major channelization projects or of regional scale hydromodification effects common in urban areas. Because of the somewhat isolated nature of localized channel armoring, their physical or biological effects are seldom monitored in a systematic way and are thus are less well understood. The goal of this project was to begin to explore indicators of the relationship between channel bank armoring and physical and biological changes in the affected reach. The study had three components, each designed to address different questions. The first component was a mapping study designed to answer the question "*What is the extent of channel alteration in a pilot study area?"* The second component applied commonly used monitoring and assessment tools to six streams in Los Angeles and Ventura counties to answer the question "*How does the physical alteration of stream channels associated with channel armoring relate to physical and biological endpoints indicative of stream condition?"* For this component we used traditional geomorphic measures, the California Rapid Assessment Method (CRAM), benthic macroinvertebrates, and stream algae. The third component focused on the impact of channel restoration to address the question "*Does stream restoration result in recovery of biological condition based on applicable indicators?*"

Major conclusions of the three components of this study are:

- We were able to identify approximately 2,200 channel modification structures based on data available from major municipalities in Los Angeles and Ventura counties. However, comparison with intensive, ground-based mapping of structures in the Malibu Creek Watershed by Heal the Bay suggests that less than 5% of existing structures are accounted for in the local agency GIS layers. Extrapolation based on this finding translates to an estimated 50,000+ in-channel structures in the two county study areas.

- Most study sites exhibited localized changes in channel morphology in the armored stream segments. In general, armored segments were flatter (i.e., lower gradient), and contained more and deeper pools and fewer riffles. These flow conditions were also associated with increased

sediment deposition. At several of the armored segments, we observed evidence of varying degrees of channel incision and toe bank failure, suggesting that bank hardening is contributing to localized incision at these sites.

- All biological indicators showed subtle, mechanistic responses to the physical changes in channel conditions in the armored segments. However, the response patterns were inconsistent among sites. Extreme heterogeneity between sites and presence of catchment-scale disturbances (e.g., fires, upstream flow control) made it difficult to ascribe observed patterns to channel armoring. General observed relationships included:
    - CRAM Biotic Structure scores were lower in the armored segments.
    - Results from two assessment tools commonly used in the European Union (River Habitat Survey and IDRAIM) showed that riparian vegetation and channel shading was more contiguous in upstream and downstream segments than in impact segments, due to the presence of a bank hardening structure, which prevents vegetation establishment.
    - Benthic macroinvertebrate diversity and tolerant taxa decreased in the armored segments. These patterns were associated with areas with higher sedimentation and lack of fast-flowing water.
    - Sediment-tolerant diatoms and soft-bodied algal taxa were more prevalent in armored segments that had higher deposition of fine-grained sediments
- Both benthic macroinvertebrate and algal taxa exhibited mechanistic responses to physical effects of armoring, but low sample size and differences between sites made it difficult to draw definitive conclusions. The data suggest that for local-scale effects, species-level or functional group-level metrics may be more sensitive tools than integrative indices of biotic integrity (IBIs).
- Neither physical nor biological effects appeared to be propagated to the downstream segments.
- The CRAM Biological Structure and Physical Structure attributes were higher at restored streams sites, suggesting that CRAM may be a good tool for monitoring restoration performance. However, it is insufficient to be used as a stand-alone tool because of the general nature of the assessment. Intensive assessment approaches will provide greater insight into ecological function and process, and hence long-term success potential of a restored site.
- Biologically based assessments hold promise for monitoring and evaluation of effects of hydromodification; however, additional work is necessary to refine relationships between physical stress and biological response.

Full Text

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