Biodiversity offsets: Why 'no net loss' is even more problematic for urban streams.

Coker, Myles E.[1,2], Walsh, Christopher J.[1], Bond, Nicholas R.[3,1] and Chee, Yung En[1]

1. School of Ecosystem and Forest Sciences, University of Melbourne, VIC

2. GHD Pty Ltd, VIC

3. Murray-Darling Freshwater Research Centre, Latrobe University, VIC

Key Points

- There is a growing body of literature that questions the effectiveness of biodiversity offsets, particularly for schemes focused on terrestrial ecosystems.
- The connected nature of stream ecosystems presents an additional problem for biodiversity offset schemes.
- Once the downstream impacts of land development are taken into consideration, policies that promote offsets may be ineffective in achieving 'no net loss' of biodiversity.
- Policies that promote the retention and reuse of stormwater runoff closer to the source are likely to better protect stream ecosystem values and deliver broader benefits to urban liveability.

Keywords

Waterway health, urbanisation, urban planning, stormwater management, market-based instruments

1. What are biodiversity offsets?

Biodiversity offsets aim to counter biodiversity loss in one location by protecting or improving biodiversity in another (Bull, Suttle, Gordon, Singh, & Milner-Gulland, 2013).

Biodiversity offsets are incorporated in many statutory frameworks relating to urban planning and development approval worldwide (McKenney & Kiesecker, 2010). For example, mitigation banks (Hough & Robertson, 2009), conservation banks (Fox & Nino-Murci, 2005), habitat banks (Morris, Alonso, Jefferson, & Kirby, 2006), biobanks (Burgin, 2008) and habitat compensation schemes (Harper & Quigley, 2005) are all schemes that incorporate biodiversity offset principles in the United States, Canada and Australia.

Generally, biodiversity offsets are applied only after options to avoid, minimise or mitigate the adverse impacts of development have been fully considered (Fallding, 2014). When such actions are not feasible, intervention (i.e. conservation, rehabilitation or restoration activity) elsewhere can be funded in compensation.

2. What does 'no net loss' mean and how is it achieved?

Offset sites and interventions are chosen to achieve 'no net loss' or 'net gain' of biodiversity, with reference to an established baseline condition. To succeed, offsets must generate 'equivalent' or 'like for like' biodiversity values to those that will be lost due to development.

Maron et al. (2012) identified a wide range of interventions that have been considered in the context of biodiversity offsets. They vary from translocation of single taxa to multi-species introductions, ecosystem repair and habitat creation.

3. Do biodiversity offsets work?

There is a growing body of literature that questions the effectiveness of biodiversity offsets (eg. Bekessy et al., 2010; BenDor, Sholtes, & Doyle, 2009; Fallding, 2014; Fisher-Vanden & Olmstead, 2013; Gibbons & Lindenmayer, 2007; Maron et al., 2012). Common criticism focuses on the intrinsic difficulties of assessing biodiversity value and achieving agreed targets.

Here we focus on an additional problem that has received less attention: the connected nature of aquatic ecosystems and the challenges this raises for offsets.

4. Why is 'no net loss' more problematic for stream ecosystems?

The connected nature of stream ecosystems presents an additional problem for biodiversity offset schemes. Water flows can transfer the adverse impacts of land development to downstream receiving environments, which is a particular issue for urban areas where new impervious surfaces are created. Conventional stormwater management strategies tend to directly connect impervious surface areas to streams via hydraulically efficient drainage systems, bypassing natural upland flow paths that allow for the retention, uptake and infiltration of stormwater within the catchment. If even small proportions of catchments are covered by impervious surfaces drained in such a way, the hydrological and ecological characteristics of downstream receiving environments tend to be critically altered (Walsh & Kunapo, 2009). In addition, these direct connections greatly increase the loads of stormwater pollutants such as nitrogen, phosphorous and toxicants, which again have far-reaching impacts on downstream receiving environments (Walsh, 2000). Collectively, these effects on stream condition have been dubbed the Urban Stream Syndrome (Walsh et al., 2005). However, their impacts can extend beyond river networks to drive eutrophication of larger aquatic ecosystems such as coastal embayments, for example (Harris et al., 1996).

If offset schemes are to achieve 'no net loss' of biodiversity, then clearly the impact of land development on downstream receiving environments must be adequately considered. However, the large spatial extent and magnitude of change engendered by stormwater systems would seem to require interventions elsewhere (i.e. in entirely different catchments) across impractically large areas to effectively offset biodiversity losses. In light of the above problems, we contend that simply broadening the scope of existing schemes to include aquatic biodiversity is unlikely to be effective.

5. Can water quality offset and trading schemes protect stream ecosystems?

As for biodiversity offset schemes, water quality offset and trading schemes that target pollutant load reduction, without also accounting for alterations to the flow regime arising from stormwater runoff, are unlikely to protect stream ecosystem values.

For example, the stormwater quality offset strategy in Melbourne targets diffuse sources of surface water pollution. The scheme requires developers to meet stormwater quality objectives by either implementing on-site stormwater treatment measures or paying an offset rate (i.e. levy) for works undertaken elsewhere (RossRakesh, Francey, & Chesterfield, 2006). The offset revenue has been used to fund the construction of regional wetland systems and stormwater treatment measures, such as rain-gardens, on public land. The program objectives were based on findings from a 1996 report (Harris et al., 1996) which identified nitrogen as the key limiting nutrient for biological processes in Port Phillip Bay, a major embayment adjacent to Melbourne (RossRakesh et al., 2006). An important assumption was that meeting nitrogen objectives would also lead to adequate reductions in phosphorus and suspended solids to protect biodiversity in Port Phillip Bay (Corbett, 2010). However, such measures alone are unlikely to protect stream ecosystems if they do not adequately address alterations to the flow regime.

Water quality trading schemes allow point-source pollution to be offset by non-point-source abatement strategies. These markets work on the principle that the marginal abatement costs of non-point-source polluters are often lower than for point-source polluters (Letson, 1992; Woodward, Kaiser, & Wicks, 2002).

For example, the Chesapeake Bay Program (CBP), initiated by Washington DC and the states of Virginia, Pennsylvania and Maryland, aimed to reduce all nutrients from controllable sources by 40% of 1985 levels by the year 2000. Since then, the CBP has set caps on nutrient loads entering the tributaries of Chesapeake Bay. Nutrient trading schemes, such as the Maryland Nutrient Trading Program (MNTP), currently allow nitrogen and phosphorus loads from point-sources (ie. industrial sites, agricultural land and oyster farms) and non-point-sources (ie. urban runoff) to be traded within catchment management jurisdictions. A common finding of ex-post evaluations of water quality trading programs has been a lack of trade due to high transaction costs (including monitoring costs), legal and regulatory obstacles and a lack of adequate regulatory incentive (Shortle, 2013).

Arguably water quality offset and trading schemes are 'necessary but not sufficient', being as they are, narrowly-focussed on pollutant load without attending to the profound changes in flow regime wrought by urban development. It follows that these schemes, which allow one source of pollution to be offset by another, are also unlikely to achieve 'no net loss' of biodiversity.

5. What are the alternatives?

The evidence is now strong that, if environmental policy is to effectively protect stream ecosystems from land development, the mechanism of ecological degradation will need to be addressed.

In urbanising landscapes, stream degradation has been observed in catchments covered by only a small area of conventionally drained surfaces (i.e. less than 2% of the total catchment area) (Walsh, Fletcher, & Ladson, 2005; Walsh & Kunapo, 2009).It is clear that conventional drainage systems, designed to deliver all impervious runoff to the nearest stream, are incompatible with maintaining stream ecosystem values. It follows that runoff from nearly all impervious surfaces on established, redeveloped and newly developed properties needs to be adequately managed, either at or near the source of runoff generation. That is, stormwater runoff should be retained for harvesting or lost through evapotranspiration, with a smaller proportion of runoff released as baseflow following adequate treatment.

Emerging approaches to local-scale stormwater management in urbanising landscapes are not necessarily characterised by economic trade-offs, particularly once broader social benefits are accounted for (Walsh, Fletcher, & Burns, 2012). For example, excess stormwater in urban catchments provides opportunities to augment conventional water supply by means of rainwater and stormwater harvesting (Jonasson & Davies, 2011). Other potential benefits include local flood-risk mitigation (Mitchell, Deletic, Fletcher, Hatt, & McCarthy, 2007) and urban cooling (Coutts, Tapper, Beringer, Loughnan, & Demuzere, 2012). These benefits can help avoid long-term costs in urban development and redevelopment, making the business case for investing in alternative stormwater management systems more compelling (Vietz, Rutherfurd, Walsh, Chee, & Hatt, 2014).

We argue that once the downstream impacts of land development are taken into consideration, policies that promote offsets may be ineffective in achieving 'no net loss' of biodiversity. Moreover, policies that promote the retention and reuse of stormwater runoff closer to the source are likely to better protect stream ecosystem values. Such approaches are likely to also deliver broader benefits to urban liveability and enable new business models to drive innovation and growth based on the generation, storage and distribution of urban stormwater.

References

Bekessy, S. A., Wintle, B. A., Lindenmayer, D. B., Mccarthy, M. A., Colyvan, M., Burgman, M. A., & Possingham, H. P. (2010). The biodiversity bank cannot be a lending bank. *Conservation Letters*, *3*(3), 151–158. doi:10.1111/j.1755-263X.2010.00110.x

BenDor, T. K., Sholtes, J., & Doyle, M. W. (2009). Landscape characteristics of a stream and wetland mitigation banking program. *Ecological Applications : A Publication of the Ecological Society of America*, *19*(8), 2078–92. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/20014580

Bull, J. W., Suttle, K. B., Gordon, A., Singh, N. J., & Milner-Gulland, E. J. (2013). Biodiversity offsets in theory and practice. *Oryx*, *47*(03), 369–380. doi:10.1017/S003060531200172X

Burgin, S. (2008). BioBanking: an environmental scientist's view of the role of biodiversity banking offsets in conservation. *Biodiversity and Conservation*, *17*(4), 807–816. doi:10.1007/s10531-008-9319-2

Corbett, D. (2010). Protecting water quality in the Bays and Waterways of Melbourne, Australia, by managing Nitrogen outputs in stormwater and sewage effluent. In *Novatech - 7th International Conference on Sustainable Techniques and Strategies for Urban Water Management*. Lyon.

Fallding, M. (2014). Biodiversity offsets: Practice and promise. *Environmental and Planning Law Journal*, *31*(1), 11–33.

Fisher-Vanden, K., & Olmstead, S. (2013). Moving Pollution Trading from Air to Water: Potential, Problems, and Prognosis. *Journal of Economic Perspectives*, *27*(1), 147–172.

Fox, J., & Nino-Murci, A. (2005). Status of species conservation banking in the United States. *Conservation Biology*, *19*(4), 996–1007. doi:10.1111/j.1523-1739.2005.00231.x

Gibbons, P., & Lindenmayer, D. B. (2007). Offsets for land clearing: No net loss or the tail wagging the dog? *Ecological Management & Restoration*, *8*(1), 26–31. doi:10.1111/j.1442-8903.2007.00328.x

Harper, D. J., & Quigley, J. T. (2005). No net loss of fish habitat: a review and analysis of habitat compensation in Canada. *Environmental Management*, *36*(3), 343–55. doi:10.1007/s00267-004-0114-x

Harris, G., Batley, G., Fox, D., Hall, D., Jernakoff, P., Molloy, R., … Walker, S. (1996). *Port Phillip Bay Environmental Study Final Report*. Canberra.

Hough, P., & Robertson, M. (2009). Mitigation under Section 404 of the Clean Water Act: where it comes from, what it means. *Wetlands Ecology and Management*, *17*(1), 15–33. doi:10.1007/s11273-008-9093-7

Letson, D. (1992). Point/Nonpoint Source Pollution Reduction Trading : An Interpretive Survey. *Natural Resources Journal*, *32*, 219.

Maron, M., Hobbs, R. J., Moilanen, A., Matthews, J. W., Christie, K., Gardner, T. A., … McAlpine, C. A. (2012). Faustian bargains? Restoration realities in the context of biodiversity offset policies. *Biological Conservation*, *155*, 141–148. doi:10.1016/j.biocon.2012.06.003

McKenney, B. a, & Kiesecker, J. M. (2010). Policy development for biodiversity offsets: a review of offset frameworks. *Environmental Management*, *45*(1), 165–76. doi:10.1007/s00267-009-9396-3

Morris, R. K. A., Alonso, I., Jefferson, R. G., & Kirby, K. J. (2006). The creation of compensatory habitat-Can it secure sustainable development? *Journal for Nature Conservation*, *14*(2), 106–116. doi:10.1016/j.jnc.2006.01.003

RossRakesh, S., Francey, M., & Chesterfield, C. (2006). Melbourne Water's stormwater quality offsets. *Australian Journal of Water Resources*, *10*(3), 241–250.

Shortle, J. (2013). Economics and Environmental Markets: Lessons from Water-Quality Trading. *Agricultural and Resource Economics Review*, *42*(1), 57–74.

Walsh, C. J. (2000). Urban impacts on the ecology of receiving waters: a framework for assessment, conservation and restoration. *Hydrobiologia*, *431*, 107–114.

Walsh, C. J., & Kunapo, J. (2009). The importance of upland flow paths in determining urban effects on stream ecosystems. *Journal of the North American Benthological Society*, *28*(4), 977–990. doi:10.1899/08-161.1

Walsh, C. J., Roy, A. H., Feminellla, J. W., Cottingham, P. D., Groffman, P. M., & Morgan II, R. P. (2005). The urban stream syndrome: current knowledge and the search for a cure. *The North American Benthological Society*, *24*(3), 706–723.

Woodward, R. T., Kaiser, R. A., & Wicks, A. B. (2002). The structure and practice of water quality trading markets. *Journal of the American Water Resources Association*, *38*(4), 967–979.