Global Costs of Achieving the Aichi Biodiversity Targets

A Scoping Assessment of Anticipated Costs of Achieving Targets 5, 8, and 14

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1.0 Background

In 2010 parties to the Convention on Biological Diversity (CBD) adopted the Strategic Plan for Biodiversity 2011 – 2020 with the purpose of stimulating a diverse array of activities by governments, NGOs, business leaders, and other stakeholders to halt the loss of biological diversity. In recognition of the critical importance of biological diversity for livelihoods, wellbeing, health and the genetic foundations of modern agriculture the parties agreed to an ambitious set of 20 targets – many of them time bound and quantitative – for slowing, halting, and reversing biological diversity loss associated with degradation of aquatic and terrestrial ecosystems throughout the world. Collectively, these are known as the Aichi Biodiversity Targets. The costs and benefits of achieving these targets are of keen interest to policy makers as they begin the process of implementing programs of work and on-the-ground activities. Choosing the most cost effective means of implementation is critical given the overall political and economic environment of fiscal austerity facing governments in both developed and developing countries.

In May of 2012, the U.K. Department for Environment and Rural Affairs (Defra) entered into an agreement with Center for Sustainable Economy (CSE) to develop a rough order of magnitude estimate (ROM) of the resource requirements of meeting three of the Aichi Targets: 5 (wetland component), 8 (pollution), and 14 (ecosystems). Our objectives are threefold: (1) to identify cost considerations associated with meeting the targets, including activities that may result in a cost savings (negative cost); (2) to lay the groundwork for a more robust assessment, and (3) to produce a first cut ROM range based on existing published information.[1]

For each target, we first refine understanding of what it will take to achieve it. We then identify key activities that are likely to help achieve the target in a cost effective manner. Subsequently, we develop portfolios of activities that represent the least cost and highest cost approaches, and then report global ROM estimates for each based on the best available information publically available at this time. We further distinguish between investment and recurring annual costs where applicable. We conclude the analysis of each target with a discussion of several optional components beyond the scope of this assessment that are of interest to Defra as part of its larger efforts to aggregate cost estimates for all Targets and to set the stage for an analysis of means of implementation.

2.0 Aichi Target 5 – Wetland Component

> "By 2020, the rate of loss of [wetlands] is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced."

2.1 Introduction and interpretation of the target

Target 5 actually addresses all natural habitats, including forests. The CSE analysis, however, is limited to the wetland component. Thus the goal is to develop ROM estimates of achieving a reduction in the rate of wetland loss of at least 50% by 2020, 100% where feasible, and in ways that also reduce degradation and fragmentation. For purpose of this costing exercise, we assume that achieving a 50% reduction in the overall rate of loss may mean a minimal reduction in some areas and perhaps as high as 100% in others.

[1] By necessity, costing the Aichi targets involves a substantial degree of uncertainty that permeates every data point along the way from estimates of baseline conditions and trends to costs of implementation across different countries to effectiveness. As such, we believe using ROM as a standard for this preliminary scoping exercise is best practice.

We also assume that activities (identified below) to achieve the target can be implemented in a manner that also reduces degradation and fragmentation. As such, we focus our cost analysis on the 50% reduction component.

An obvious point of departure for the costing exercise is to calculate the baseline rate of loss for major wetland communities so that Target 5 can be translated into hectares conserved (i.e. loss prevented) per year and total over the 2012 – 2020 period. Ideally, baseline rates of loss would tier to the 47 marine and inland wetland types identified by the Ramsar Convention classification system for wetland types as approved by Recommendation 4.7 and amended by Resolution VI.5 of the Conference of the Contracting Parties.[2] While estimates of the global rate of loss for each Ramsar wetland type have not been generated, there are a handful of global assessments available that can serve as the starting point for our analysis.

The most rigorous of these assessments developed data on current extent and annual rate of loss either in percentage or absolute terms for six major wetland categories including mangroves, seagrass, salt marsh, peatlands, freshwater wetlands and delta plains. Crooks et al. (2011) compiled global estimates for the rate of loss of coastal and near-shore wetlands including mangroves, sea grass meadows, salt and freshwater tidal marshes. Waycotta et al. (2009) addressed global loss of seagrass beds. Coleman et al. (2008) completed a detailed study of wetland losses in the world's major delta regions. FAO (2007) completed a global assessment of mangrove loss. Bishop and Rennaud (2011) reported figures for mangroves, seagrass, and salt marsh and drew rates of loss from Butchart (2010). In addition, we incorporated figures published in the 2005 Millennium Ecosystem Assessment (MEA 2005) to account for wetlands not covered in these other categories. After adjusting for losses incurred subsequent to assessment dates with study-specific rates of loss and eliminating overlap, we produced an estimate of the current rate of loss at 1% and 2% per year for seven wetland categories. Table 2-1 synthesizes the results of this analysis. Three key conclusions emerge:

- The global rate of loss of all wetlands is probably in the order of 11.65 to 23.30 million hectares per year. At a rate of 1.5% each year, this translates into an annual loss of 17.47 million hectares.
- This implies a conservation target of 5.83 to 11.65 million hectares per year to achieve the goal of halving the rate of loss. At a loss rate of 1.5% the annual target would be 8.74 million hectares.
- If that conservation target were achieved in 2012 and sustained, it would result in protection of nearly 79 million hectares that would otherwise be lost by 2020.

Table 2-1
Rough Estimate of Wetland Conservation Needed to Achieve Target 5

Wetland type	Global extent 2012 (ha)	Rate of loss @ 1.5 % (ha/yr)	Conservation target (ha/yr)	2020 Conservation target (ha)
Mangroves	14,720,762	220,811	110,406	993,651
Seagrass	17,434,500	261,518	130,759	1,176,829
Salt Marsh	39,200,000	588,000	294,000	2,646,000
Peatlands	384,800,000	5,772,000	2,886,000	25,974,000
Other freshwater wetlands	97,855,164	1,467,827	733,914	6,605,224
Major delta plains	56,640,494	849,607	424,804	3,823,233
All other wetlands	554,250,030	8,313,750	4,156,875	37,411,877
Total	1,113,600,000	17,473,514	8,736,757	78,630,814

[2] For a complete description of the Ramsar wetland types, see: http://www.ramsar.org/cda/ramsar/display/main/main.jsp?zn=ramsar&cp=1-26-76%5E21235_4000_0__.

2.2 Actions to implement the target and synergies with other targets

To identify key activities that could be undertaken to achieve this conservation target, we first considered major drivers of loss, degradation, and fragmentation reported in the literature. These are relatively well understood, and include coastal development, agricultural conversion, water diversions, channelization, dams, roads, invasive species and climate induced sea level rise (MEA 2005). Given this, our first criteria for selecting activities to reduce the rate of loss is to focus on those which have immediate impacts on the ground in addressing these drivers of change, excluding climate, which we presume should not be addressed via Aichi since it is being negotiated separately under other international processes. Our second criteria was to focus on activities with zero or negative costs first, then activities that are relatively low cost but high impact, and finally those that come with a fairly hefty price tag and relatively lesser impact only if necessary. Our third criterion was to focus on activities that can simultaneously help achieve other targets. With these criteria in mind and after review of activities identified in national biodiversity action plans and other sources, we developed a list of activities to incorporate into the cost exercise. These include:

- Removing harmful subsidies and other forms of public support for non-essential infrastructure that impinges on natural wetland habitats.
- Implementing "no net loss" standards and associated wetland banking systems similar to effective programs managed in the United States and European Union.
- Using payments for ecosystem services to provide cost share assistance for agriculture and forestry best management practices to protect wetland communities affected by these land uses.
- Improving national wetland inventory, monitoring and enforcement capabilities.
- Increasing the amount of wetlands of international importance designated under the Ramsar Convention or otherwise protected in national wildlife refuges, parks, or conservation units.

Rationale for including these activities is discussed below. There are many potential synergies and co-benefits associated with achieving Target 5 with respect to other Aichi Targets, especially Targets 11, 14 and 15. Target 11 addresses the need to expand the area of terrestrial and aquatic ecosystems represented in officially protected areas and so overlaps with the public acquisition aspects of Target 5. Target 14 includes wetland restoration, which is also included here in the context of no net loss wetland banking programs. Target 15 also can be interpreted to include a wetland restoration component, since many of the wetlands now included in the Ramsar network and other protected designations are degraded somewhat and are being prioritized for restoration funding.

2.3 Method of assessment and relationship to GEF

Our cost methodology began by refining the actions into discrete line items that could be researched for global investment and recurring cost estimates and determining their respective magnitudes of implementation. We folded improved national capacity for wetland inventory, monitoring and enforcement into overall management costs associated with wetland banking and acquisitions and so did not break those out separately. We then researched a range of unit cost estimates (if needed) from the literature, seeking data points from both developed and developing countries and bringing all estimates up to $2012 values. Where possible, we distinguished between investment needs (i.e. total needs to achieve an activity goal) and recurring expenses (i.e. expenses that would arise after the activities were complete). Finally, we developed two unit cost scenarios that represent our best guess as to the highest and lowest ends of the cost ranges. We conclude the discussion of each action with a comparison to what is included in the analysis of funding needs in the latest Global Environmental Facility (GEF) assessment.

2.3.1. Reduced spending on dams and other harmful infrastructure

With respect to harmful subsidies and other forms of public support, public expenditures on new dam construction and other forms of water infrastructure detrimental to biological diversity and other aspects of environmental quality were identified as the most promising sources of cost savings with beneficial impacts on wetlands conservation. A recent global assessment estimates that over $1.1 trillion dollars is being spent each year on new water infrastructure, and so the potential for trimming this investment back to help achieve environmental quality objectives is high, and should rigorously investigated (Tal 2009). Cancellation of high impact dams should be a priority, since by directly flooding wetlands and reducing water flows needed by river deltas and other wetlands downstream new large dams present a major risk to wetlands. After a decade or so of little activity, new dams for water supply, flood control, and hydropower are now experiencing a global construction boom. Data on building trends and new storage capacity targets worldwide suggests that the equivalent of 20 new large dams per year may be constructed over the next decade (Lempériѐre 2006; World Water Futures 2011). Intensive studies in several affected regions suggest that anywhere from 35 to 55% of these new dam proposals come with unacceptably high environmental and social costs and are largely unnecessary (See, e.g. Survival International 2010; International Rivers 2011). Based on construction cost data provided by Lempériѐre (2006), cancellation of half the new proposals each year between 2013 and 2020 in order to help achieve Aichi wetland conservation targets could save roughly $5.70 billion per year.

Another option for water infrastructure savings is associated with adopting green infrastructure over conventional gray solutions, such as using wetlands and riparian zones to control flooding or purify water rather than new filtration plants or sea walls. Talberth and Gray (2012) developed a global methodology and compiled numerous case studies to demonstrate that investing in green rather than gray infrastructure could represent a cost savings of 10 to as high as 80 percent. To be conservative, we assume that at least 5% of funds now planned for new gray water infrastructure could be reallocated towards green solutions that conserve wetlands. Added to savings from cancellation of high impact dams, it suggests that roughly 10% ($11.40 billion) of the amount of global spending on water infrastructure ($114 billion annually) could be eliminated to reduce wetland loss without significant effects on economic development.

All of these cost savings can be classified as reductions in investment expenditures. With respect to the GEF assessment, they were not included and so we include no comparison here.

2.3.2. Wetland banking and other "no net loss" programs

In the United States, the European Union, Australia and other settings a growing number of national, state, and local agencies are implementing what has been referred to as "no net loss" programs for wetlands which permit new wetland development only if entities who receive such permits can demonstrate that an equivalent amount of wetlands either from an area or functionality standpoint are replaced through wetland restoration activities. Most often, these programs require that wetland loss be offset at rate of 2 or more wetlands restored for each one developed (this is the replacement ratio, which we assume for simplicity to be 1:1 in this analysis). There are many specific forms of no net loss programs. Wetland banking is one that has received the most widespread interest in that it retains the most flexibility and is consistent with market-based principles. Under wetland banking, wetland developers must purchase enough wetland credits to offset their impacts, and these credit purchases are deposited with a regional wetland bank that uses the funds to restore wetlands in other areas that provide ecosystem services as least as great as those developed.

While there are many criticisms and concerns with these programs – for instance, whether or not the restored wetlands can really be compared to what is being lost – these programs nonetheless can provide a basis for costing out the Aichi 5 targets if we assume that at least some of the target is achieved by way of wetland banking arrangements. There are two major costs to consider: (a) the price of wetland credits paid by private entities seeking wetland development permits, and (b) the costs public agencies incur in managing the permitting process and otherwise providing oversight for the banking programs. We surveyed available data on wetland credit prices as well as program management fees from a number of sources, including Ecosystem Marketplace (Madsen et al. 2010), U.S. Army Corps of Engineers (2005) and the BushBroker program in Australia. Globally, Madsen et al. (2010) totals suggest current credit prices average $33,721 per hectare, and they range from $22,356 to $404,000 in the individual program datasets we reviewed. When credits are purchased, they are rolled into the annual payment schemes that finance typical development projects (such as bonds for public works or commercial loans) and so we annualized these credits over a 10 year payback period at an opportunity cost of capital at 7% and a 3% discount rate to arrive at a ROM range of credit prices as they would be incurred on an annual basis ranging from $3,000 to $30,000 for purposes of our analysis.

These expenses can be considered investment, since they are part of the up front costs wetland developers would pay to initiate projects. The GEF assessment did not consider wetland banking programs as part of its assessment for Target 5 so we provide no comparison here.

In addition to up front investments in credit purchases, public and private entities managing wetland banking programs experience recurring costs for administering the permit programs and follow up monitoring. Available data from the programs we reviewed suggests a ROM range for these activities to be $150 to $1,500 per hectare.

2.3.3. Payments for ecosystem services

Another activity that could help reduce the rate of wetland loss is for public entities to develop and implement payment for ecosystem services (PES) programs as an incentive for landowners who control wetland acreage to maintain those wetlands as functioning ecosystems rather than sell them off when market pressures rise. Under a typical PES scheme, a landowner enrolls in the program and enters into a contractual arrangement whereby he or she receives annual payments that represent the current non-market value of the wetland ecosystem services they control. To be effective the contractual arrangement must be longer term. Often they mirror those for conservation easements that are typically 99 years or more. While most active PES programs are found in developed countries, PES markets are nonetheless expanding in developing countries as well. For example, consider the latest tabulation of PES markets from Madsen et al. (2010): Latin America (10 countries, $147,389,886 in payments, 1,144,636 hectares protected since 2007); South and Southeast Asia (33 active programs, $89,159,150 in payments, 170,270 hectares protected). While it may be challenging to develop PES schemes in areas where they do not now exist before 2020, still, they may play a significant role if pursued aggressively. To be conservative, we assume that no more than 50% of the wetland acreage conserved through public acquisition programs would be achieved by way of PES.

The literature on PES is well developed, and rapidly expanding. It is beyond the scope of this analysis to offer a review of PES in general, rather, we focus on what it may cost for public entities seeking to achieve Aichi Target 5 for wetlands through PES for the several ecosystem services intact wetlands provide. Theoretically, the maximum a public entity would be willing to pay would be equal or less than the current non-market value of the ecosystem services provided by the lands in question. A recent meta-analysis of non-market ecosystem service values for wetlands assembled by WWF (Schuyt and Brander 2004) reported median values of $162 to $505 per hectare for five wetland types in $2012. A weighted average based on the distribution of the conservation targets set forth in Table 2-1 is $262 per hectare. Note that this is a median value. We could expect half the wetlands considered for additional protection to achieve Target 5 to have annual ecosystem service values significantly greater than this. Moreover, a contractual payment of $262 per year would probably not be enough in most developed world settings to counter development pressure, and so this value should be considered one that lies on the lowest end of the anticipated cost range.

An earlier, widely cited valuation meta-analysis of global wetlands by Woodward and Wui (2001) found values ranging from $13.19 to $5,325 per hectare for single services. Of most interest here are services related to habitat protection and associated recreational and fisheries uses. A mean across these important services is $4,464 per hectare per year. Taking this study and the WWF study into consideration, we adopt $400 to $4,000 as a reasonable ROM cost range. As PES represent long term annual payments, we consider wetland conservation based on PES to be a recurring expenditure in the context of this analysis.

2.3.4. Direct acquisition at fair market value

While PES schemes are a more indirect way of eliminating development risk on threatened wetlands, direct acquisition for wildlife refuges, parks, open space and other forms of permanent protection is a more direct route that should play a prominent role in achieving Target 5 objectives. Acquisition programs administered by public agencies, land trusts, and conservation organizations involve two major cost considerations: (a) purchase costs, typically at fair market value (which also includes economic opportunity costs) and (2) ongoing management costs associated with additions to a nation's or land trust's system of protected areas.

For each of these cost categories, we developed a set of ROM unit cost estimates based on a review of available data sources and translation of that data into common units. Data were reviewed from several continents and several situations including coastal development in Australia (Curtis 2008), management of conservation units in Brazil (Medeiros et al. 2011), palm plantation establishment costs in Indonesia (Sargeant 2001), wetland acquisition in Texas (FORSB 2011), the EU Natura program (Kaphengest et al. 2011), a global meta analysis of opportunity costs by Brander et al. (2006), the North American Wetland Conservation Act program (NAWCC 2010), the World Bank and the U.S. National Wildlife Refuge System (Thompson and Pinkerton 2008). Annualized to reflect the likely payoff period for public financing mechanisms these data suggest a global range of $460 to $10,189 acquisition cost per hectare and a range of $4.68 to $76.00 per hectare in protected area management costs. As such, we adopt a ROM cost range of $1,000 to $10,000 for the former and $5 to $50 for the latter.

Acquisition of wetlands can be considered an investment cost, while their long-term management as part of protected areas involves a recurring expense. With respect to GEF, direct acquisition of wetlands to achieve Target 5 objectives was not considered in the global cost assessment since its focus was on forests.

2.4 <u>Assessment of resource needs</u>

In this section we summarize the implementation and unit cost data presented in Section 2.3 and develop two total cost scenarios. Results are discussed in Section 2.5.

2.4.1. Implementation assumptions, unit costs, and data gaps

Table 2-2 presents implementation and unit cost data for the three major actions discussed in Section 2.3. Unit costs are further subdivided into investment and recurring categories, where investment costs are generally understood as one-time expenditures needed to achieve the target and recurring costs are those which are likely to continue on over an indefinite time period.

Given the coarse global nature of these figures, there are many ways to improve their accuracy. Implementation goals should be refined based on country specific data wherever possible. For example, identifying the amount of spending on dams and other forms of harmful water infrastructure that could be trimmed to help achieve Target 5 goals is necessarily a country-by-country process that would require gathering data on government expenditures and environmental impact of specific dam proposals.

Implementation goals for the other actions would similarly benefit from a country-by-country analysis that distinguished between unprotected wetlands generally and those considered at immediate risk of loss so that conservation programs could have the most direct impact on loss rates. Unit cost data could be refined by significantly expanding the number of data points included and delving deeper into issues such as how acquisition costs would be financed (which as bearing on the annual payments that would result), which ecosystem services would be of highest priority to maintain, and appropriate replacement ratios for wetland credits.

Nonetheless, given that the estimates presented in Table 2.3-1 are ROM, global, and based on an analysis completed over a very short time frame, they present a good starting point for the next phase of this work.

Table 2-2
Unit Cost Estimate for Select Target 5 Activities

Activity	Low ($/ha)	High ($/ha)	Primarily Investment?	Primarily Recurring?
Wetland acquisition (mean)	$700	$7,000	Yes	No
Fair market value	$1,000	$10,000	Yes	No
Payments for ecosystem services	$400	$4,000	No	Yes
Protected area management	$5	$50	No	Yes
Wetland credit prices	$3,000	$30,000	Yes	No
Wetland mitigation management	$150	$1,500	No	Yes

2.4.2. Total cost scenarios

Based on these unit cost ranges, we then developed two cost scenarios that reflect our best guess as to the lower and upper limits of the cost range for achieving Target 5. The two scenarios were based on different proportions of the annual target conserved by private entities by way of wetland credit purchases or public entities by way of land or development right acquisition (PES) and associated management costs. Unit costs for each scenario were assumed to represent mean values at the center of each of the ranges discussed in Table 2-2. In each scenario, we exclude negative costs associated with reduced public infrastructure spending for now but consider this in the discussion of potential funding mechanisms.

In Scenario 1, public agencies would bear 75% of the responsibility of reducing wetland loss through public acquisition programs that are evenly split between fee simple purchases at fair market value and payments for ecosystem services negotiated through either conservation easements or agricultural and forestry best management practice contracts. The remaining 25% of the Target would be achieved by private entities through wetland banking programs that require fully functional offsets of each hectare of wetland developed. In Scenario 2, these shares are reversed.

2.5 Results

The overall results are presented in Table 2-3 and 2-4. In Table 2-3, we present the estimated resource needs for each activity broken out by investment needs and recurrent expenditures. Investment needs cover the 2013 to 2020 period. Recurrent expenditures are totaled over this period as well. In Table 2-4, we combine investment and recurrent expenditures into one figure for each scenario, but then report an annual average over the 2013 to 2020 period.

Table 2-3
Total Resource Needs by Expenditure Type and Scenario

	Investment needs 2013 – 2020 $billions		Recurrent annual expenditures ($billions/yr)		Recurrent total 2013 – 2020 ($billions)	
Target 14 Action	S1	S2	S1	S2	S1	S2
Wetland banking	288.31	864.94	0	0	0	0
Payments for ecosystem services	0	0	2.29	0.76	18.35	6.12
Fair market value acquisitions	183.47	61.16	0	0	0	0
Recurring public management costs*	0	0	2.71	5.71	21.63	45.65
Total	$471.78	$926.10	$5.00	$6.47	$39.98	$51.77

* *These figures include annual adjustments to account for new protected area coverage.*

Table 2-4
Total Resource Needs and Annual Average by Scenario

	Total resource needs 2013 – 2020 ($billions)		Average annual 2013 – 2020 ($billions)	
Target 14 Action	S1	S2	S1	S2
Wetland banking	288.31	864.94	36.04	108.12
Payments for ecosystem services	18.35	6.12	2.29	0.76
Fair market value acquisitions	183.47	61.16	22.93	7.64
Recurring public management costs	21.63	45.65	2.70	5.71
Total	$511.76	$977.86	$63.96	$122.23

**Columns or rows may not total due to rounding*

2.6 Discussion of results

Our ROM estimates for resource needs to achieve Target 5 in the 2013 to 2020 period range from $511.76 billion in our low cost scenario to $977.86 in the high cost scenario (or $6,468 to $11,723 per hectare) implying annual expenditures in this period of $63.96 to $122.23 billion. This is the cost range for protecting 79 million hectares of wetlands that would otherwise be lost to development. The relatively high cost of Scenario 2 makes intuitive sense because the costs of creating new wetlands that are functionally equivalent to those lost is much higher than merely protecting wetlands that exist now. The high cost (in absolute terms) of Scenario 1 reflects the financial and economic costs of protecting wetlands that are of high value to alternative land uses.

While different countries may experience different costs associated with Target 5 activities, we expect that the unit cost ranges we adopted (ROM) are sufficiently large to encompass country to county differences in wage rates, cost of land, and other factors that may have bearing. This expectation is bolstered by the inclusion of unit cost data from different global settings.

Given that our aim was to develop a reasonable ROM estimate of costs associated with a discrete set of Target 5 activities developed collaboratively with the project team and implemented at a scale determined by studies outside the scope of this work, we are confident that the cost ranges are sufficiently accurate. Of course, they are sensitive to many factors such as scale of implementation and precise nature of the activities. These factors are external to our analysis, and somewhat subjective, and so different analysts using different assumptions about what activities are appropriate and on what scale they should be implemented will find significantly different results. Nonetheless, and as contemplated by the methodology supplement that helped guide this work, we are confident that the results presented here represent “a pragmatic approach designed to provide a plausible first assessment of the likely magnitude involved, which will provide a basis for discussion and an be refined through later analysis.”[3]

2.7 Discussion of optional elements

Sections 2.0 to 2.6 represent required elements of our scope of work established by the TOR for this study with Defra. In addition to these elements, Defra has asked if possible to address in at least a cursory manner a series of additional aspects originally excluded or omitted from the TOR or identified as optional. As the resources and time allocated to this analysis were entirely consumed by elements 2.0 to 2.6, we can offer only a few thoughts on these optional elements:

2.7.1. Additional resource needs

Ideally, the total costs to achieve Target 5 would be expressed in terms of additional resources above and beyond what international institutions, national, state, and local agencies, charitable organizations, research institutes and others have committed. With respect to wetland banking, the most recent global tally by Ecosystem Marketplace indicates that transactions associated with various wetland banking or compensatory mitigation programs affect over 86,000 hectares per year at a market value of $2.9 billion (Madsen et al. 2010). With respect to public acquisitions, the best data on the scope of existing programs are contained in reports submitted by parties to the Ramsar Convention. Ramsar parties hope to secure protection of 250 million hectares by 2015, up from 193 million today. The question, however, is to what degree protections offered under Ramsar affect wetlands that would otherwise be lost. If there is little overlap, then the effect on the rate of loss would be negligible. On the other hand, if the overlap is high, it is conceivable that adding 57 million hectares to designated sites over the next three years could make a significant dent in the rate of loss.

In addition to Ramsar information, there are many national level assessments that can be obtained and at least a few regional analyses to help understand the resources already committed to slowing the rate of wetland loss. In the United States, for example, grants and contributions by project partners made under the North American Wetlands Conservation Act have averaged $232 million per year since 1990.[4] Thus, it appears likely that a substantial portion of the total costs to achieve Target 5 is already committed in one form or the other. This warrants careful consideration in the next phase of this work.

2.7.2. Further research needs and gap analysis

As noted previously, this analysis could be refined further with more precise figures on the rate of loss of wetlands of various types, the addition of a larger set of unit cost data, and more precise activity descriptions and implementation goals developed on a country-by-country basis. Further research should be based on findings from a statistically valid sample of Target 5 activities in developed, transition, and developing countries and from a sufficient diversity of ecosystem types to capture the range of variability in on the ground settings. Table 2-5 is a gap analysis table provided by Defra to summarize information related to future research needs.

[3] UNEP, WCMC, ICF, GHK Draft Methodology Paper, 14 June 2012, Section 3.
[4] For a program overview and funding statistics, visit: http://www.fws.gov/birdhabitat/Grants/NAWCA/index.shtm.

Table 2-4
Target 5 Gap Analysis

	Target 5
Evidence on costs	*Strength of evidence*: high *Extent to which further research is required*: medium
Evidence on current levels of expenditure	*Strength of evidence*: medium *Extent to which further research is required*: medium
Other Aichi Targets	
Links to other Targets	Targets 11, 14, 15
Evidence on potential co-benefits	*Strength of evidence*: high *Extent to which further research is required*: some
Other policy areas	
Related policy areas outside of biodiversity	Coastal zone management, water quality, water infrastructure, climate, recreation
Evidence on potential benefits to other policy areas	*Extent of potential benefits*: high *Extent to which further research is required*: some

2.7.3. Benefits of delivering the target

Benefits of wetland conservation are well documented in terms of protecting a wide range of ecosystem services including flood control, recreational and commercial fisheries, wildlife watching, hunting, amenities, habitat and storm protection. The economic value of these ecosystem services provided by wetlands conserved to achieve Target 5 could be expected to range between $125 and $2,156 per hectare per year (Woodward and Wui 2001) and enhance policy objectives related to coastal zone management, water quality, water infrastructure, climate and recreation.

2.7.4. Funding opportunities and sources of funding

If our estimate of the amount of funding from cancellation of high impact dams and other harmful forms of water infrastructure to achieve Target 5 goals is accurate ($11.70 billion a year) and politically if such funding could be diverted, it would help finance a significant portion of the annual expenditure needed to implement wetland banking and public acquisition programs. Other funding mechanisms are discussed in Section 2.7.1.

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3.0 Aichi Target 8

> "By 2020, pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity."

3.1 <u>Introduction and interpretation of the target</u>

To define Target 8, we first conducted a literature review of global pollution and its impacts on biodiversity. We found nutrient pollution, solid waste pollution of the marine environment, and air pollution to be the most frequently cited stressors for biodiversity and ecosystem function (MEA 2005; Costello et al. 2010; WWF 2012; Derraik, J.G.B. 2002). Thus, the goal of our analysis is to determine ROM estimates of reducing these pollution sources to levels not detrimental to ecosystem function and biodiversity. As all countries contribute to pollution to some degree, we targeted our analysis on geographic areas determined to be most important for safeguarding ecosystem function and biodiversity as defined by biodiversity hot spots, major pollution centers, and global sanitation targets.

To further refine this target, we conducted a literature review to determine major pollution sources for each stressor listed above. We also reviewed spatial analyses to see how these stressors overlap with biodiversity hot spots. To further define nutrient pollution, we used best available spatial data on dead zones (Diaz et al. 2011) and overlaid this with spatial data on biodiversity hot spots from Conservation International (Mittermeier 2004). Only coastal dead zones were included in this analysis as mapping was largely not available for freshwater zones. From this data, we targeted 162 coastal eutrophic and hypoxic areas within 46 countries. The two major nutrients contributing to dead zones are nitrogen (N) and phosphorus (P) (Selman and Greenhalgh 2009). The main sources of nitrogen runoff include wastewater containing human excrement and household and industrial waste, stormwater overflow from urban areas, and agricultural fertilizer and manure runoff (Selman and Greenhalgh 2009; NOAA 2012). We focus on these three pollution sources for the targeted 162 coastal dead zones.

To determine the extent of marine debris pollution in the world's oceans we conducted a literature review to determine the composition of marine debris, estimates of total debris currently in the world's oceans, and flow of solid waste entering the world's oceans annually. Plastics are by far the dominant source of marine debris, constituting approximately 158 million tonnes (McIlgorm et al. 2008). Once in the ocean, 15% of debris floats on the sea surface, 15% remains in the water column, and 70% sinks to the seabed (UNEP 2005). It is difficult to determine to what extent each country contributes to marine debris so we focus on global solid waste production. UNEP (2005) states that roughly 6.4 million tonnes of litter enters the world's oceans annually. Plastic comprises between 60—80% of total litter, or between 3.8 and 5.1 million tonnes.

For air pollution, we first conducted a literature review to determine the major pollution types. The major air pollutants contributing to biodiversity loss include nitrogen oxides, sulfur dioxide, particulate matter, ozone, carbon monoxide, and lead.[5] Major sources of these pollutants include fossil fuel combustion at power plants, industrial emissions, and transportation and cities are by far the largest pollution centers (U.S. EPA 2012). As a result, we focus our analysis on reducing pollution from cities. We identified the top ten most heavily polluted cities based on sulfur dioxide, nitrogen dioxide, and particulates to see which countries have the biggest impact on biodiversity (McIntyre 2010 and WHO 2010).

There are multiple challenges associated with costing out Target 8. First, there is the challenge of data availability and quality. While pollution can generally be categorized into land, air, and water pollution, there are multiple pollution pathways that impact biodiversity. Countries have varying reporting and monitoring requirements for identifying and quantifying these pathways and pollution sources. Additionally, countries also vary in terms of data availability and transparency. As a result, it is difficult to ascertain the extent of the global pollution problem and pollution reduction targets. A second challenge lies in defining "levels not detrimental to ecosystem function and biodiversity." Countries have varying targets for pollution reduction and prevention requirements. Additionally, countries monitor and place different values on ecosystem function and biodiversity. As a result, and where possible, we use data on best available technologies and best available knowledge on appropriate pollution reduction standards per unit area.

3.2 Key activities to achieve the target:

To select actions to implement Target 8, we followed our overall criteria of identifying at least one action that can be implemented at a negative cost and others that are likely to have a high impact on affected ecosystems and biodiversity, and also contemplated in existing NBSAPs. Through a review of available information, literature, and NBSAPs we developed the following list of actions:

- Removal of perverse agricultural subsidies leading to excess nutrient use.
- Development of marine debris clean-up programs including mechanical cleanup of floating plastic debris and voluntary buy-back programs.
- Investments in converting synthetic plastic production to biodegradable plastic production.
- Increase in wastewater treatment capacity to cover populations living upstream of dead zones without access to sanitation.
- Reduction of nutrient runoff from upstream agricultural operations through the use of best management practices.
- Investments in urban stormwater retrofits for existing impervious surface areas and green infrastructure options
- Installation of best available technologies for stationary and mobile sources of pollution including industries and coal-fired power plants.

Target 8 is most relevant to COP decisions on inland waters biodiversity, marine and coastal biodiversity, and the International Initiative on Soil Biodiversity. Additionally, as Target 8 focuses on transboundary

[5] These six pollutants are regulated by the U.S.A., Australia, and the European Union.

air and water pollution problems, it is also relevant to COP decisions on biofuels and biodiversity, forest biodiversity, and mountain biodiversity. In terms of policy areas, this target is most relevant to the areas of climate change, human health, energy, agriculture, and aquaculture.

Target 8 activities have the potential to overlap with activities covered by targets 3, 7, 10, and 14. Target 3 focuses on removing perverse subsidies. We discuss in this section how eliminating perverse agricultural subsidies would be a negative cost in that this money could be redirected towards sustainable agricultural practices. We discuss these negative costs, separately, however. To avoid overlap with targets 7 and 10, we cross-walked our activities list with the marine and agricultural clusters to also ensure no cost overlap. Target 14 is covered under this cluster, so we ensure no overlaps. Delivering on Target 8 could, however, influence costs associated with other targets. For example, addressing nutrient pollution from both agricultural runoff and air pollution will help reduce eutrophication as well as damage to coral reefs. This could lower costs associated with Targets 10 and 14, which focus on safeguarding coral reefs based on current estimates of reefs at risk.

There are also potential overlaps between pollution sources within Target 8 itself. For example, nitrogen enters water bodies from both agricultural runoff and air pollution. Addressing air pollution might reduce nitrogen runoff from agricultural areas. As the relationship, however, is unclear, we assume no overlap.

3.3 Method of assessment and relationship to GEF

As with Targets 5 and 14, our cost methodology began by refining the actions into discrete line items that could be researched for global investment and recurring cost estimates and determining their respective magnitudes of implementation. We then researched a range of unit cost estimates (if needed) from the literature, seeking data points from both developed and developing countries and bringing all estimates up to $2012 values. Where possible, we attempted to gather data for both investment needs (i.e., total needs to achieve an activity goal) and recurring expenses (i.e., expenses that would arise after the activities were complete). Finally, we developed two unit cost scenarios that represent our best guess as to the highest and lowest ends of the cost ranges. The GEF needs assessment states, "[u]ltimately no activities under this Target are considered to be covered under the GEF." As a result, there is no overlap with this analysis and we do not discuss the assessment any further in this section.

3.3.1. Cost savings associate with reduction in agricultural subsidies

We targeted agricultural subsidies as a potential negative cost for Target 8. The Environmental Working Group found that reforming U.S. federal farm programs could make a significant reduction in nutrient runoff to the Gulf of Mexico dead zone (Booth 2006). Additionally, it has been argued that agricultural subsidies can increase nutrient pollution by promoting the conversion of forests and wetlands into agricultural land, and by sending price signals to farmers to farm more intensively by growing the same crop year after year without crop rotation (Porter 2002). With respect to cost savings on agricultural subsidies, we were able to identify a coarse global estimate on total agricultural spending by governments for OECD and non-OECD countries. Estimates of global subsidies for both production and consumption range from $314 billion to $424 billion per year (OECD 2009; Robin et al. 2003). A necessary next step would be to identify the percent of this funding that goes towards promoting inefficient agricultural practices and technologies such as increased chemical fertilizer use and inefficient tillage practices. Nourish 9 Billion (2012), a joint initiative by the Biodivision Foundation and Millennium Institute, states that farm subsidies worldwide total $350 billion a year and this typically goes towards industrial agriculture. As this figure lies within the range established by OECD (2009) and Robin et al. (2003), we adopt this figure in our discussion of potential funding sources.

3.3.2. Marine debris reduction

To determine the cost of reducing marine debris, we assume both cleanup and remediation must take place. We first determined the amount of global plastic production that would need to be converted to biodegradable plastic by estimating the annual amount of plastic entering the world's oceans. We multiplied this amount by the cost differential between synthetic and biodegradable plastic production using industry estimates from Omnexus (2012) and Plastmart (2012). We assume no investment costs are needed for the production of biodegradable plastics, only a change in material costs. Estimates are based on an average of all synthetic and biodegradable plastic types (e.g., LDPE, HDPE, polystyrenes, etc…).

For marine debris cleanup costs, we also conducted a literature review to determine methods of cleanup which have been most effective. Volunteer cleanup has been shown to be effective for shoreline cleanup, but we assume converting to biodegradable plastics will address shoreline pollution. We therefore focus our analysis on cleanup of floating plastic debris using mechanical cleanup and buy-back programs which pay fishermen to collect debris. Mechanical cleanup costs are based on a global estimate calculated by the 5 Gyres Institute (2012) who estimate a total global cost of $13 billion per year using supertankers. Buy-back program costs are based on data from Korea's buy-back program. Cho (2009) estimated that both investment and annual costs came out to $905 per tonne of trash collected.

3.3.3. Nutrient runoff reduction

While both N and P contribute to dead zones, for purposes of this analysis we focus solely on N pollution to avoid cost overlap as implementing best management practices and technologies that address N will also address P.

Our first action under nutrient reduction is to increase wastewater treatment capacity to cover populations living upstream of dead zones without access to sanitation. We tie our analysis to the Millennium Development Goal (MDG) target for sanitation, which states, "[h]alve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation." To calculate a ROM to meet this MDG target for our key countries, we first determined the current proportion of the population in each country lacking access to sanitation using the MDG indicators database which identifies proportion of the population with access to adequate sanitation by country (UN Statistics Division 2012). We applied this percentage to the total global population living upstream of target zones. We estimated the population size needed to reduce this proportion to half of 1990 levels to be 43.9 million people. We then found cost data on the average cost per person of improved sanitation to meet the MDG target. Hutton and Haller (2004) estimate this cost to be between $6.13 and $7.60 per person per year.

Our second action targets nutrient runoff from agricultural operations. To determine the cost of reducing nonpoint source pollution from agriculture, we first determined the total upstream area of agricultural land that lies within the same watershed as our targeted dead zones. Based on the FAO-AGLW 2011 dataset, we estimate this area to be over 554 million acres. We then calculated an average nutrient load rate for N from agricultural land using the best available data (largely from the Chesapeake Bay area). As a low estimate we calculated an average agricultural nutrient loading rate of 5.9 kg/ha based on Jeje (2006), which summarizes nutrient load rates reported from several studies in Canada and the United States. For a high estimate, we use data from the Chesapeake Bay to determine an average nutrient load rate of 13.5 kg/ha for agriculture (WRI 2012).

Our next goal was to determine a target reduction amount for N. Many countries have national policies in place (e.g., total maximum daily loads) to target reduction amounts. Based on a survey of available data from the Chesapeake Bay, the Gulf of Mexico, and the Baltic Sea, we assume an overall global reduction for N of 50% by 2020 (U.S. EPA 2012a; Kroger et al. 2012; Helsinki Commission 2012). To determine the cost of meeting this target, we determined the average cost per hectare for a suite of agricultural BMPs known to reduce nutrient runoff. There are a number of sources estimating costs. We use available data from the Chesapeake Bay (Talberth et al. 2010a, 2010b; Chesapeake Bay Program 2011) and Germany (Schmalz et al. 2011). These BMPs include: nutrient management (fertilizer use reduction), conservation tillage, cover crops, riparian forest buffers, grass buffers, water control structures, and animal waste management. As it is difficult to determine to what extent each BMP should be implemented, we calculated an average annual cost of implementation of $26.80/kg.

Our third action, investments in urban stormwater retrofits, is based on the cost needed to retrofit stormwater infrastructure in urban areas. To determine the baseline amount of N to reduce, we calculated the urban area in the same upstream watershed as our coastal dead zones using data from FAO-AGLW 2011. We assume both scenarios have the same acreage of approximately 10 million hectares. We use the same methodology listed above for our agricultural nutrient reduction action to determine an average N runoff rate from stormwater and urban land. We determined a range of 1.12—47.17 kg N/ha runoff based on data from Canada, Japan, the United States, China, and Virginia (Jeje 2006; Kunimatsu et al. 2006; Virginia DCR 2007).

From this data we were able to calculate total nutrient runoff from stormwater per year for target countries. To determine a target reduction amount for N, we assume that the 50% target by 2020 for agriculture also applies to stormwater. To determine the cost of meeting these targets, we used the average cost per kg of stormwater control measures known to reduce nutrient runoff based on values reported in Branosky and Talberth (2012). The average value was $368.87.

3.3.4. Air pollution reduction

Air pollution from industrial activities, transportation, and energy production causes or contributes to eutrophication, the acidification of water bodies and soils, reduction in plant photosynthesis, and reduction of reproduction success (Phoenix et al. 2006; Lovett et al. 2009; Zvereva et al. 2009). The major air pollutants contributing to biodiversity loss include nitrogen oxides, sulfur dioxide, particulate matter, ozone, carbon monoxide, and lead. Cities are by far the largest pollution centers. As a result, we concentrate our cost methodology on reducing pollution for the top ten cities for worst air quality based on analysis by 24/7 (McIntyre 2010) using data from the World Health Organization (WHO). These cities are Beijing, China, New Delhi, India, Santiago, Chile, Mexico City, Mexico, Ulaanbaatar, Mongolia, Cairo, Egypt, Chongqing, China, Guangzhou, China, Hong Kong, China and Kabul, Afghanistan.

Air pollution is transboundary in nature and it is difficult to identify a global level of total pollution and global reduction target. Additionally, given differences in data monitoring and reporting across countries, it is difficult to determine the number of industries and air quality controls needed for each country, let alone air quality standards. As a result, we base our cost estimates on an average pollution reduction cost per unit GDP for available countries.

We first conducted a literature to determine which countries have conducted reports to estimate the cost of meeting air quality regulations. We identified data for the United States (U.S. EPA 2011) and Europe (Wagner 2010). If we assume these countries have some of the stricter guidelines in the world, then our cost estimate is based on bringing countries with cities listed in the top ten up to speed. We divided total cost estimates for the U.S. and Europe by their 2011 GDP using data from the World Bank (2012). We average these estimates and applied it to the GDP of each country for the cities we include in this analysis.

Because it is almost certain that most existing or planned air quality programs in the cities and countries in our analysis will be implemented to achieve non-biodiversity objectives such as public health and mitigation of climate change, our last step was to estimate the share of total air quality costs that may be needed to address biodiversity concerns. We can expect that any additional investment in air quality to accomplish biodiversity objectives would be proportional to the magnitude of biodiversity benefits relative to other categories of benefit. In the case of the U.S. Clean Air Act, EPA estimates that environmental benefits (which include agricultural and forest productivity, recreation, and ecosystems) would represent roughly 4% of the total benefit (U.S. EPA 2011). This is perhaps on the low side because it excludes one of the major sources of benefit – passive use, or non-use values, which are often far greater. To be conservative, we make the assumption that roughly 10% of the total cost of meeting air quality goals would be related to biodiversity and its wide range of use and non-use benefits.

3.4 Assessment of Resource Needs

In this section we summarize the implementation and unit cost data presented in Section 3.3 and develop two total cost scenarios. Results are discussed in Section 3.5

3.4.1. Implementation assumptions, unit costs, and data gaps

Table 3-1 presents implementation and unit cost data for the major actions discussed in Section 3.3. Unit costs are further subdivided into investment and recurring categories, where investment costs are generally understood as one-time expenditures needed to achieve the target and recurring costs are those which are likely to continue on over an indefinite time period. Of the activities considered, annual production of biodegradable plastics to replace conventional plastics and wastewater treatment are largely recurring expenditures that will be needed after 2020, while the remainder reflect investments during the 2013 to 2020 period.

Given the coarse global nature of these figures, there are many ways to improve their accuracy. Implementation goals should be refined based on country specific data wherever possible. For example, identifying the precise amount of nutrient runoff from agricultural lands, cities, and wastewater treatment plants is necessarily a country-by-country process that would require gathering data on nutrient loads for each of these sectors.

Unit cost data could be refined by significantly expanding the number of data points included and delving deeper into issues such as the exact agricultural best management practices and wastewater and air pollution technologies are appropriate in different country settings. Nonetheless, given that the estimates presented in Table 3-1 are ROM, global, and based on an analysis completed over a very short time frame, they present a good starting point for the next phase of this work.

3.4.2. Total cost scenarios

Our two cost scenarios are based on using the upper and lower bounds for both implementation units and costs. So Scenario 1 is based on the lowest range of implementation and the lower bound of the cost range. Scenario 2 is based on the highest range of implementation and the higher bound of the cost range. In both scenarios, we exclude the potential cost savings from reductions in agricultural subsidies as this is discussed as a potential funding source in section 3.6.

Table 3-1
Implementation Goals and Unit Costs for Target 8 Actions

Target 8 Action	Implementation (units)	Cost range (units)	Primarily investment?	Primarily recurring?
Marine Litter				
Biodegradable plastic	3.84 – 5.12 (million tonnes/yr)	$1,250 -$1,713 ($/tonne/yr)	No	Yes
Debris cleanup	23.63 (million tonnes/yr)	$1.4 – $2.2 ($billion/yr)	Yes	No
Nutrient pollution				
Wastewater	43,900,468 (people)	$6.13 - $9.33 ($/person/yr)	No	Yes
Agricultural	3.0 – 6.8 (kg N/ha/yr)	$26.80 ($/kg)	Yes	No
Stormwater	0.57 – 23.81 (kg N/ha/yr)	$368.87 ($/kg)	Yes	No
Air Pollution*	10 (cities)	$0.005 ($/$GDP)	Yes	No

**These reflect total costs. As discussed in the text, we attribute just 10% of these costs to meeting Aichi biodiversity goals.*

3.5 Results

The overall results are presented in Tables 3-2 and 3-3. In Table 3-2, we present the estimated resource needs for each activity broken out by investment needs and recurrent expenditures. Investment needs cover the period 2013—2020. Recurrent expenditures are totaled over this period as well. In Table 3-3 we combine investment and recurrent expenditures into one figure for each scenario, but then report an annual average over the 2013—2020 period.

Table 3-2
Total Resource Needs by Expenditure Type and Scenario

	Investment needs 2013—2020 $billions		Recurrent annual expenditures ($billions)		Recurrent total 2013—2020 ($billions)	
Target 8 Action	S1	S2	S1	S2	S1	S2
Biodegradable plastic	0	0	24.14	42.24	193.15	337.92
Debris cleanup	13.00	21.38	0	0	0	0
Wastewater	0	0	0.27	0.41	2.15	3.28
Agriculture	353.91	810.83	0	0	0	0
Stormwater	16.70	703.43	0	0	0	0
Air pollution	47.90	47.90	0	0	0	0
Total	$431.51	$1,583.54	$24.41	$42.65	$195.30	$341.20

Table 3-3
Total Resource Needs and Annual Average

	Total resource needs 2013—2020 $billions		Average annual (2013 – 2020) ($billions)	
Target 8 Action	S1	S2	S1	S2
Biodegradable plastic	193.15	337.92	24.14	42.24
Debris cleanup	13.00	21.38	1.63	2.67
Wastewater	2.15	3.28	0.27	0.41
Agriculture	353.91	810.83	44.24	101.35
Stormwater	16.70	703.43	3.34	87.93
Air pollution	47.90	47.90	5.99	5.99
Total	$626.81	$1,924.74	$79.61	$240.59

3.6 Discussion of results

Overall, the global cost of meeting target 8 in the 2013—2020 period ranges from $627 billion in our low cost scenario to $1,924 billion in our high cost scenario, implying annual expenditures in this period of $79.61–$240.59 billion. Of our three pollution sources, nutrient runoff is the most costly to reduce largely due to the use of agricultural BMPs that cost an average of $26.80 for every kilogram.

This analysis is heavily focused on costs for developed countries, so we expect that costs could be considerably lower when incorporating costs for developing countries as low cost technologies and incentive programs are available for developing countries.

Given that our aim was to develop a reasonable ROM estimate for costs associated with a discrete set of Target 8 activities developed collaboratively with the project team and implemented at a scale determined by the studies outside the scope of this work, we are confident that the cost ranges are sufficiently accurate. Of course, they are sensitive to many factors such as scale of implementation and precise nature of the activities. These factors are external to our analysis, and somewhat subjective, and so different analysts using different assumptions about what activities are appropriate and on what scale they should be implemented will find significantly different results. Nonetheless, and as contemplated by the methodology supplement that helped guide this work, we are confident that the results presented here represent "a pragmatic approach designed to provide a plausible first assessment of the likely magnitude involved, which will provide a basis for discussion and an be refined through later analysis."[6]

3.7 Discussion of optional elements

Sections 3.0 to 3.6 represent required elements of our scope of work established by the TOR for this study with Defra. In addition to these elements, Defra has asked if possible to address in at least a cursory manner a series of additional aspects originally excluded or omitted from the TOR or identified as optional. As the resources and time allocated to this analysis were entirely consumed by elements 3.0 to 3.6, we can offer only a few thoughts on these optional elements:

3.7.1. Additional research needs

Ideally, the total costs to achieve Target 8 would be expressed in terms of additional resources above and beyond what international institutions, national, state, and local agencies, charitable organizations,

[6] UNEP, WCMC, ICF, GHK Draft Methodology Paper, 14 June 2012, Section 3.

research institutes and others have committed. We are not aware of any global compilations on existing levels of investment in Target 8 actions.

3.7.2. Further research needs and gap analysis

As noted previously, this analysis could be refined further with the addition of a large set of unit cost data, and more precise activity descriptions and implementation goals developed on a country-by-country basis. Further research should be based on findings from a statistically valid sample of Target 8 activities in developed, transition, and developing countries and from a sufficient diversity of ecosystem types to capture the range of variability in on the ground settings. Table is a gap analysis table provided by Defra to summarize information related to future research needs.

Table 3-4
Target 8 Gap Analysis

Evidence on costs	*Strength of evidence:* medium *Extent to which further research is required*: medium
Evidence on current levels of expenditure	*Strength of evidence:* (not included in this phase of research) *Extent to which further research is required* Considerable
Other Targets	
Links to other Targets	Targets 3, 7, 10, 14
Evidence on potential co-benefits	*Strength of evidence:* high *Extent to which further research is required:* some
Other policy areas	
Related policy areas outside of biodiversity	Climate change, rural development, health, agriculture, energy, and aquaculture, indigenous communities, transportation, industry
Evidence on potential benefits to other policy areas	*Strength of evidence:* high *Extent to which further research is required:* some

3.7.3. Benefits of delivering the Target

Reducing pollution of air, water, and land resources has a plethora of societal benefits. Addressing nutrient and marine pollution, for example, lowers the costs of treating water, increases recreational opportunities, improves fish habitat and health, increases property values, avoids costs associated with dredging and finding water supply substitutes, and increases aesthetic and existence values for biodiversity (UNEP 2012). Multiple studies have attempted to estimate the economic benefits of pollution prevention and remediation actions. A recent report by McIlgorm et al. 2008 estimated that the cost of marine debris to the 21 APEC countries alone is $1.27 billion per year. In other words, addressing marine debris would lead to an avoided cost of $1.27 billion per year.

In terms of the benefits of using improved stormwater practices, the city of Philadelphia in thee United States recently conducted a benefits assessment comparing green with gray stormwater infrastructure. They found that using green stormwater controls (e.g., native vegetation, swales, green roofs) provided over $2.8 billion U.S. dollars (USD) in benefits while traditional stormwater controls provided only $122 million USD (Stratus Consulting Inc. 2009).

For wastewater treatment, benefits associated with improved sanitation include time savings associated with better water access, improved human health and increase in productivity, and value of prevented deaths. Hutton and Haller (2004) estimate that every dollar spent on improving sanitation generates an average economic benefit of $8.5 (Hutton and Haller 2004). In relation to our estimate, this would mean a global economic benefit of $1.88–$2.87 billion USD per year, or a present value from 2012–2020 of $16.95–$25.8 billion USD.

For air pollution, the U.S. EPA estimates that the benefits of the Clean Air Act from 1990 – 2020 is roughly $2,040 billion, while costs are only $66 billion. This estimate is based on reduction in air-quality related premature death and illness, and improvements in visibility, commercial timber, agriculture, recreational fishing, and materials damage. In terms of a cost-benefit ratio, each dollar spent on reducing air pollution results in an economic benefit of $30.

3.7.4. Funding options

If our estimate of the amount of agricultural subsidies could be canceled to achieve Target 8 goal is accurate ($350 billion in funding a year), and politically if such funding could be diverted, it would offset the cost of these activities. As such, we strongly recommend linking funding for Target 8 activities to reductions in spending for unnecessary and environmentally harmful agricultural activities.
There are many other programs at the international, national, state and local level to advance work on the activities we developed for Target 8. In terms of policy options, several cost-effective options exist. Zanou et al. (2003) list the following cost-effective instruments: charge-taxes, tradable permit systems, subsidies, deposit-refund systems, non-compliance fees, liability payments. Other policy options include sustainable consumption and production regulations to reduce plastic use, and policies that encourage the use of best available technologies and agricultural/stormwater practices.

Target 8 References

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4.0 Aichi Target 14 – Ecosystem Restoration

> "By 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable."

4.1 Introduction and interpretation of the target

All ecosystems contribute to human well-being, health, and livelihoods, but some have been studied more in terms of their benefits and values. We conducted a literature review to determine which ecosystems should be prioritized by Target 14 activities. After taking available research into consideration and overlap with other clusters we determined that activities for the following major ecosystem types should be examined further for Target 14 – wetlands, coral reefs, rivers and forests. Since many of the activities associated with protection/ restoration of rivers are overlapped by those included in our analysis of wetlands (i.e. protection of river deltas, cancellation of new dams) we concentrated our costing analysis on the other three.

Refining the scope of this target further presents many formidable challenges. Defining what services are essential or not is a largely subjective exercise. For example, all ecosystems provide services that may be essential to some groups. Another complication is the balance between safeguarding and restoring. For purposes of this analysis, we chose to focus on restoration since we assume that actions to safeguard (i.e. through establishment of protected areas) would be addressed by way of other targets such as Targets 5 and 11. The one exception was the negative cost savings associated with reduced new road construction, discussed below, which can rightly be interpreted as an action to safeguard existing natural habitats. And perhaps the most challenging aspect of this target is making direct links between specific ecosystem types and women, indigenous, local, poor, and vulnerable communities. This would entail a fairly sophisticated global mapping project that combines ecosystem data with demographic and economic data to hone in with more precision on where the two themes intersect; although broad inferences can certainly be made (i.e. tropical rain forests and indigenous communities certainly overlap).

4.2 Actions to implement the target and synergies with other targets

To select actions to implement Target 14, we again followed our overall criteria of identifying at least one action that can be implemented at a negative cost and others that are likely to have a high impact on affected ecosystems and also contemplated in existing NBSAPs. Through a review of available information, literature, and NBSAPs we developed the following list of actions:

- Removal of subsidies and other forms of public support for harmful infrastructure such as dams and new road construction that destroy, fragment, or degrade ecosystems.
- Investments in traditional ecological knowledge (TEK) or the factual knowledge about ecological systems, processes, and uses held by traditional and indigenous peoples.
- Restoration of wetlands through the removal of dams, coastal dikes or new constructed wetlands.
- Forest landscape restoration, which includes restoring functionality and productive capacity to forests and landscapes in order to provide food, fuel, and fiber, improve livelihoods, store carbon, improve adaptive capacity, conserve biodiversity, prevent erosion and improve water supply.
- Physical restoration and reestablishment of coral reefs.

Clearly, one of the major drivers of ecosystem degradation worldwide is public infrastructure, especially roads that fragment intact interior forests and other wildlands and provide vectors for intrusion of alien species and human-caused disturbances of many kinds. Fragmentation by roads has been cited as perhaps the single greatest threat to the biodiversity of large, intact landscapes. Thus, we selected reduction of public support for new roads as one of the actions that could be implemented at a negative cost. Cost savings associated with reduced expenditures on new dams and other water infrastructure was addressed in Target 5, and so not repeated here.

Investments in TEK are essential for identifying specific linkages between ecosystems and well-being for rural, indigenous and traditional communities. For example, in the context of global food security there is increasing interest in agro-ecological systems employed by traditional communities as a way to improve resilience, productivity and adaptability of modern agriculture in the face of climate change. Surveying TEK associated with agro-ecological systems must precede actions that either safeguard or restore the specific ecosystems and plant communities on which such systems rely. Such surveys can also be used to identify and prioritize restoration techniques. Restoration of wetlands, coral reefs, and forests was included because as discussed these are high value ecosystems with numerous benefits for health, livelihoods and well-being, there is good global data on the extent to which these ecosystems are degraded, and their restoration is directly responsive to the overall goals of the Target.

There are many potential synergies and co-benefits associated with achieving Target 14 with respect to other Aichi Targets. For example, cost saving measures identified for this Target may overlap with those presented in Target 3. To the extent that restoration activities implemented under Target 14 include those that address invasive alien species there may be synergies with Target 9. Coral reef restoration activities carried out under this target will obviously help advance Target 10. Ecological restoration actions may overlap with those contemplated by Targets 11 and 15. And finally, any Target 14 activities designed to better document TEK will also help achieve the of goals of Target 18.

4.3 Method of assessment and relationship to GEF

As with Targets 5 and 8, our cost methodology began by refining the actions into discrete line items that could be researched for global investment and recurring cost estimates and determining their respective magnitudes of implementation. We then researched a range of unit cost estimates (if needed) from the literature, seeking data points from both developed and developing countries and bringing all estimates up to $2012 values. Where possible, we distinguished between investment needs (i.e. total needs to achieve an activity goal) and recurring expenses (i.e. expenses that would arise after the activities were complete). Finally, we developed two unit cost scenarios that represent our best guess as to the highest and lowest ends of the cost ranges. We conclude the discussion of each action with a comparison to what is included in the analysis of funding needs in the latest Global Environmental Facility (GEF) assessment.

4.3.1. Cost savings associated with reduction in new road expenditures

With respect to cost savings on new road construction, we were able to identify a coarse global estimate on new road construction spending per year by the World Bank, as a function of country-level GDP (World Bank 2012).[7] Based on this estimate, it appears that annual road spending globally falls in the range of .75 to 1.5% of GDP per year, with the majority on new roads. Adopting 1% as a rough global figure, it implies annual new road spending of roughly $780 billion per year. The question is how much of this new road construction can be eliminated to safeguard large, intact ecosystems? Of course, this can only be answered on a site specific basis with reference to particular road projects of concern on a country by country basis and with the needs of poverty eradication and sustainable development taken into consideration.

In the U.S., there is one organization that compiles such data regularly as part of its budget oversight functions. The most recent estimate implies that at least 13% of new road spending in the U.S. could be eliminated to save taxpayer money and protect fragile landscapes (FOE 2012).[8] In less developed countries, this proportion is probably higher since it is likely that new roads impact more intact landscapes. Nonetheless, if we adopt the 13% figure as a placeholder it implies that over $108 billion a year could be trimmed from global road expenditures in order to safeguard ecosystems of high ecosystem service value. The magnitude of this value suggests that it warrants a careful consideration during the next phase of this work.

This value represents a negative cost savings related to an annual investment. With respect to GEF, the GEF needs assessment did not consider this element.

[7] See World Bank roads data at: http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTTRANSPORT/EXTROADSHIGHWAYS/0,,contentMDK:20468505~menuPK:338669~pagePK:148956~piPK:216618~theSitePK:338661,00.html.

[8] This value represents the dollar value of annual Highway Trust Fund planned expenditures determined to be of high ecological impact and largely unnecessary divided by the annual expenditure on highways by federal, state, and local agencies.

4.3.2. Investments in traditional ecological knowledge

With respect to TEK, the key to developing a ROM estimate of resource needs is to identify the size of the population with potential TEK relevant to restoration of forests, wetlands, and coral reefs and then develop a survey protocol that would yield a statistically valid sample. This is an exceedingly complex task that would have to begin with identification of regions where TEK is known to be a significant factor in agricultural production and rural health and then using the geographic and demographic profiles of these regions to identify additional regions where surveys should be targeted. There are no existing global studies that have attempted this.

While a solid estimate of TEK potential broken out by the three biomes at issue is beyond the scope of this report, we can get a crude sense by considering current global data on the population and distribution of indigenous peoples. While indigenous peoples are not the sole repositories of TEK, it is a good place to start since the cultural continuity of TEK over time within indigenous communities can be expected to be far greater than in non-indigenous communities where TEK plays a lesser role. The most recent global analyses indicate that the number of indigenous people worldwide is approximately 370 million, distributed amongst 5,000 separate groups in 72 countries.[9] A program of work to inventory TEK in this population relevant to restoration of forests, coral reefs, and wetlands would have to be distributed geographically to include the diverse biomes supporting these populations. The survey protocol should then aim to distribute this work amongst 5,000 indigenous groups and 72 countries. A solid inventory should consider at least 100 surveys per group.

Survey costs vary widely, as it is dependent upon travel distance, complexity of the survey instrument, number of interviews needed to obtain a single usable observation, etc. A recent TEK survey conducted in a fairly remote section of the Arctic incurred roughly $1,500 per usable result taking into consideration all data gathering and analysis tasks (Fox 2002). Surveys closer to population centers could probably be completed at a much lower rate. As an initial estimate, we use $150 to $1,500 as the ROM cost range per survey and the basis for the two cost scenarios. TEK surveys are one-time expenditures and thus fall into the broad investment category used in this report. Once compiled, there is no additional recurring cost burden.

The GEF report does include TEK as a line item with respect to Aichi Target 14. The basis for the GEF estimate includes "[s]ub global assessments and other methodologies and tools that compile information on the services provided by ecosystems and the benefits received by local and indigenous communities."[10] GEF estimates were based on an assumed cost of $2 million per country, and the basis for the cost range varied the number of countries covered from 30 to 90. The GEF estimate range was thus $60 to $180 million. The primary difference between our estimates and GEF are a focus on indigenous groups (5,000) rather than countries, and use of a unit cost data from actual TEK surveys rather than the broad UK Ecosystem Service Assessment that formed the basis of the $2 million figure cited by GEF.

4.3.3. Wetland restoration

Under Target 5, one of the key actions investigated was the use of offset or mitigation mechanisms for unavoidable wetland loss associated with future development activities. Those mitigation or offset mechanisms were assumed to be part of a "no net loss" wetland banking system adopted in countries with high rates of wetland loss and similar to the ones in place in the United States and parts of the EU. Under wetland banking, all wetland losses are offset by restoration of an equivalent area adjusted to ensure

[9] International Work Group for Indigenous Affairs: Global estimates at: http://www.iwgia.org/regions.
[10] Based on Target 14 summary provided by UNEP-WCMC 8/10/12.

equivalency in ecosystem service function. Thus, the challenge here is to identify any additional wetland restoration activities needed to achieve Target 14 not already contemplated by Target 5.

One way to do this is to simply concentrate on the wetlands that have already been protected from development, but still require restoration actions. Ramsar designations provide the logical starting point, since many of the wetlands within the Ramsar system are in need of various levels of restoration to maintain their ecological integrity over time. Currently, the total surface area of designated sites stands at 193,553,062 hectares.[11] As evidenced by programs specifically targeted at these wetlands, restoration needs vary considerably from removing debris and other sources of pollution to large-scale dike and dam removal or other methods to restore water flows (ICWRP 2012). For purposes of this analysis, we assume that all currently designated Ramsar sites are in need of at least some minimal level of restoration investment.

There are a number of sources on which to draw to cost out wetland restoration activities of various intensities. Alexander and McInnes (2012) recently documented costs for replanting mangroves ranging from $22 to $440 per hectare, with the latter project of limited success. A detailed green infrastructure analysis by Nocker and Mazza (2010) for the Sigma Plan II in the Scheldt Estuary and the Lower Danube Green Corridor Plan found the cost of various restoration activities to range from $13,755 to $354,265 per hectare with a weighed mean of $137,903. Most of the activities considered were of the more intensive nature (i.e. excavation of landfill, dyke realignment, river reconnections) and considered all economic costs including forgone agricultural production. In the Mississippi Alluvial Valley Jenkins et al. (2010) estimated total economic costs of roughly $1,500 per hectare for a set of low intensity restoration practices that could be implemented by individual landowners. Actual restoration costs (excluding economic opportunities) was approximately $1,000 per hectare. Thus, there is a very wide range of restoration costs, depending on what kind of wetland is involved, the intensity of restoration needed, and whether or not economic opportunity costs are factored in.

For purposes of our analysis, we assume that all economic costs can be excluded since Ramsar sites have already been taken out of production, and that most are in relatively good shape already and will not require restoration activities at the high end of the spectrum. As such, we adopt a ROM range of $100 to $1000 per hectare as a starting point based on the low end cost estimates from the literature. All such costs can be considered investment costs since once restoration activities are complete, no additional costs are incurred. With respect to GEF, the GEF analysis did not address wetland restoration in the context of the Target 14 analysis.

4.3.4. Forest landscape restoration

Forest landscape restoration actions span a diverse range of actions such as replanting, thinning, reintroduction of fires, closure and obliteration of unnecessary roads and control of alien species. As with wetland restoration, these actions have a wide range of costs and applicability worldwide. Globally, it is estimated by the Forest Landscape Restoration Global Partnership that there is a total area of lost and degraded forest lands of more than 1 billion hectares worldwide that is suitable and available for restoration.[12] Restoring this vast acreage would, of course, come at an enormous financial cost. A more tractable target for Aichi 14 may be, as in the case of wetlands, to aspire at least in the short term to a "no net loss" standard and target the number of hectares restored each year at the current rate of deforestation.

[11] See official Ramsar figures at: http://www.ramsar.org/cda/en/ramsar-news-internationalworkshopwetlandrestorationbeijing/main/ramsar/1-26%5E25301_4000_0__.
[12] See: http://www.profor.info/knowledge/assessing-potential-forest-landscape-restoration.

Most recent estimates place that rate at roughly 13 million hectares per year.[13] We adopt this as a starting point for our analysis.

In terms of restoration costs, there are numerous assessments to consider that provide unit cost estimates for a wide range of techniques of varying intensity for various forest types. For example, FAO completed a recent estimate of conventional and assisted regeneration in the Philippines and reports a range of $580 to $1,050 per hectare. A detailed analysis of lands degraded by cattle in the Lacandon rainforest region in Mexico estimated restoration costs at $1,268 per hectare (Román-Dañobeytia 2012). In the U.S., an average cost of $1,448 per hectare is used as an estimate of establishing forest vegetation on the national forest system (Gorte 2009). Many other studies fall into this general range. These data suggest an acceptable unit cost range of $500 to $1500 per hectare as the basis for our cost scenarios.

In one sense, these costs are certainly an investment cost since once a hectare is restored, little or no costs are incurred. But since annual restoration targets are tied to annual deforestation rates, they can be interpreted as a recurring annual expenditure that will be required indefinitely into the future until deforestation rates are brought to zero. So for purposes of our analysis we assume that the forest restoration expenditure is a recurring cost. With respect to GEF, the GEF assessment did not address forest restoration needs in the discussion of Target 14.

4.3.5. Physical restoration and reestablishment of coral reefs

As with wetlands and forests, restoration of coral reefs takes many forms ranging from relatively low cost actions such as community-based transplantation to high cost measures such as artificial reef establishment. Coral reef restoration is still in its infancy as a discipline. A few rehabilitation projects appear to have been successful at scales of up to a few hectares; many, perhaps most, have failed or not met original expectations (Edwards 2010). Whether active restoration is likely to be a cost-effective intervention depends primarily on 1) the causes of the degradation and 2) the state of the reef.

The aims of restoration may vary considerably, from fisheries rehabilitation to restoration of benthic biodiversity to shoreline protection; all require different approaches. The state of the local environment is also relevant in that if conditions are poor as a result of human impacts, major management initiatives will be needed before any active restoration takes place (Edwards 2010). Scale of restoration and rehabilitation is another challenge. Edwards (2010) states, "[t]here is much talk of 'large-scale' restoration but the reality is small-scale, mostly sub-hectare. The largest project to date appears to have restored about 7 hectares." For the purposes of this analysis, we ignore scale assume and assume an average restoration cost across restoration methods.

In order to establish an appropriate scope for Target 14 actions, we first noted that restoration and safeguarding of coral reefs could overlap with Target 10. To avoid double counting, we contacted the lead for this target to discuss restoration actions included here and limited our analysis to those with no overlap.

We then we considered the most recent global status report on reefs and their condition. There are at least 255,000 square kilometers of coral reefs worldwide. Of these, 19% are considered severely degraded, while another 15% are thought to be under imminent risk from human pressures (CRTR 2010). If we limit our focus on severely degraded reefs, it implies a restoration target of 4,845,000 hectares. The U.S. EPA presents a more conservative estimate, and reports the percent of coral reefs that are currently degraded to be roughly 10% (U.S. EPA 2012). This would imply a 2,555,000-hectare target. Another approach is suggested by Edwards (2010) who states, "active restoration should normally be limited to

[13] See latest UN estimates at: http://www.un.org/apps/news/story.asp?NewsID=34195.

well-managed marine protected areas, sanctuaries, parks or areas under some form of de facto protection (e.g. resort reefs)." To determine the scale of restoration based on these criteria, we looked at the percent of coral reefs in marine protected areas that have deemed only partially effective in protection or ineffective as an upper bound. Burke et al. (2011) estimate that 17% of coral reefs fall under this category. This implies a 4,250,000-hectare restoration target. As this is very close to the CRTR estimate and perhaps more precise and appropriate for Target 14 since the target reefs lie within MPAs we adopt it here.

The costs of reef restoration vary widely, but have been addressed in at least a handful of assessments that considered common factors. For the lower cost line items such as transplantation and biological site restoration both Edwards (2007) and Spurgeon and Lindhal (2000) found a similar range of values in the $2,200 to $53,000 range per hectare. Haisfield et al. (2010) found restoration costs involving rock pile installation to be roughly $48,000 per hectare. Assuming that a global Target 14 program focuses on lower cost, community based restoration programs of most benefit to those directly dependent on reefs suggests that it would be appropriate to skew the unit cost range toward the lower end of this spectrum. Thus for purpose of this analysis we assume a unit cost range of $2,500 to $25,000 per hectare.

All such expenditures fall into the category of an investment. As with forest restoration, coral reef restoration was not considered as part of the GEF 14 assessment so we do not provide a comparison here.

4.4 Assessment of resource needs

In this section we summarize the implementation and unit cost data presented in Section 4.3 and develop two total cost scenarios. Results are discussed in Section 4.5.

4.4.1. Implementation assumptions, unit costs, and data gaps

Table 4-1 presents implementation and unit cost data for the five actions discussed in Section 4.3. Unit costs are further subdivided into investment and recurring categories, where investment costs are generally understood as one-time expenditures needed to achieve the target and recurring costs are those which are likely to continue on over an indefinite time period.

Given the coarse global nature of these figures, there are many ways to improve their accuracy. Implementation goals should be refined based on country specific data wherever possible. For example, identifying the amount of spending on new road construction that could be trimmed to help achieve Target 14 goals is necessarily a country-by-country process that would require gathering data on government expenditures and environmental impact of specific road proposals. Implementation goals for the other actions would similarly benefit from a country-by-country analysis. Unit cost data could be refined by significantly expanding the number of data points included. Nonetheless, given that the estimates presented in Table 4.3-1 are ROM, global, and based on an analysis completed over a very short time frame, they present a good starting point for the next phase of this work.

Table 4-1
Implementation Goals and Unit Costs for Target 14 Actions

Target 14 Action	Implementation (units)	Cost range (units)	Primarily investment?	Primarily recurring?
Reduction of high impact road expenses	13% of new road expenses	-$108.00 ($billions/yr)	Yes	No
Traditional ecological knowledge – interview based surveys	50,000 (usable surveys)	$150 - $1,500 (per survey)	Yes	No
Wetland restoration	193,553,062 (hectares)	$100 - $1,000 (per hectare)	Yes	No
Forest landscape restoration	13,000,000 (hectares/yr)	$500 - $1,500 (per hectare)	No	Yes
Physical restoration and reestablishment of coral reefs	4,250,000 (hectares)	$2,500 - $25,000 (per hectare)	Yes	No

4.4.2. Total cost scenarios

By holding implementation units constant, the basis for the two cost scenarios considered is lower and upper bounds of the unit cost ranges. Scenario 1 incorporates the lower bound unit costs, Scenario 2 the upper bound costs. In the scenarios, we exclude the potential cost savings from reductions in high impact road expenditures as this is discussed as a potential funding source in Section 4.6.

4.5 Results

The overall results are presented in Tables 4-2 and 4-3. In Table 4-2, we present the estimated resource needs for each activity broken out by investment needs and recurrent expenditures. Investment needs cover the 2013 to 2020 period. Recurrent expenditures are totaled over this period as well. In Table 4-3, we combine investment and recurrent expenditures into one figure for each scenario, but then report an annual average over the 2013 to 2020 period.

Table 4-2
Total Resource Needs by Expenditure Type and Scenarios

	Investment needs 2013 – 2020 $billions		Recurrent annual expenditures ($billions/yr)		Recurrent total 2013 – 2020 ($billions)	
Target 14 Action	S1	S2	S1	S2	S1	S2
TEK surveys*	.01	.08	0	0	0	0
Wetland restoration	19.36	193.55	0	0	0	0
Forest landscape restoration	0	0	6.50	65.00	52.00	520.00
Restoration of coral reefs	10.63	106.25	0	0	0	0
Total	$30.00	$299.88	$6.50	$65.00	$52.00	$520.00

* Rounded up to nearest $10,000,000

Table 4-3
Total Resource Needs and Annual Average

Target 14 Action	Total resource needs 2013 – 2020 ($billions) S1	S2	Average annual 2013 – 2020 ($billions) S1	S2
TEK surveys	.01	.08	0.00125	0.00938
Wetland restoration	19.36	193.55	2.42	24.19
Forest landscape restoration	52.00	520.00	6.5	65.00
Restoration of coral reefs	10.63	106.25	1.33	13.28
Total	$82.00	$819.88	$10.25	$102.48

**Columns may not total due to rounding*

4.6 Discussion of results

Our ROM estimates for resource needs to achieve Target 14 in the 2013 to 2020 period range from $82.00 billion in our low cost scenario to $819.88 in the high cost scenario, implying annual expenditures in this period of $10.25 to $102.48 billion. Of the five actions considered, surveys of traditional ecological knowledge were by far the least costly – amounting to no more than $75 million – while physical restoration of wetlands was the most costly, a cost that could approach $194 billion if implemented fully in all Ramsar sites that need restoration activities. The only recurring expenditure considered here are those that relate to forest restoration, since the stockpile of forestlands in need of restoration is continually growing as deforestation continues.

While different countries may experience different costs associated with Target 14 activities, we expect that the unit cost ranges we adopted (ROM) are sufficiently large to encompass country to county differences in wage rates, cost of capital, and other factors that may have bearing. This expectation is bolstered by the inclusion of unit cost data from different global settings.

Given that our aim was to develop a reasonable ROM estimate of costs associated with a discrete set of Target 14 activities developed collaboratively with the project team and implemented at a scale determined by studies outside the scope of this work, we are confident that the cost ranges are sufficiently accurate. Of course, they are sensitive to many factors such as scale of implementation and precise nature of the activities. These factors are external to our analysis, and somewhat subjective, and so different analysts using different assumptions about what activities are appropriate and on what scale they should be implemented will find significantly different results. Nonetheless, and as contemplated by the methodology supplement that helped guide this work, we are confident that the results presented here represent "a pragmatic approach designed to provide a plausible first assessment of the likely magnitude involved, which will provide a basis for discussion and an be refined through later analysis."[14]

4.7 Discussion of optional elements

Sections 4.0 to 4.6 represent required elements of our scope of work established by the TOR for this study with Defra. In addition to these elements, Defra has asked if possible to address in at least a cursory manner a series of additional aspects originally excluded or omitted from the TOR or identified as optional. As the resources and time allocated to this analysis were entirely consumed by elements 4.0 to 4.6, we can offer only a few thoughts on these optional elements:

[14] UNEP, WCMC, ICF, GHK Draft Methodology Paper, 14 June 2012, Section 3.

4.7.1. Additional resource needs

Ideally, the total costs to achieve Target 14 would be expressed in terms of additional resources above and beyond what international institutions, national, state, and local agencies, charitable organizations, research institutes and others have committed. We are not aware of any global compilations on existing levels of investment in TEK surveys, wetland restoration, forest restoration, or coral reef restoration on which we can rely. There are, however, often-national level assessments that can be obtained and at least a few regional analyses. In the United States, annual budget requests contain line items for many relevant programs but they often have to be teased out from larger expenditure data. For example, U.S. budgetary commitments for 2013 include over $4 billion for conservation and restoration programs affecting forests and wetlands implemented by just one major agency – the Department of Agriculture.[15] Thus, a more robust examination of additional requirements for Target 14 should include an inventory of major programs like these at the national level.

4.7.2. Further research needs and gap analysis

As noted previously, this analysis could be refined further with the addition of a large set of unit cost data, and more precise activity descriptions and implementation goals developed on a country-by-country basis. Further research should be based on findings from a statistically valid sample of Target 14 activities in developed, transition, and developing countries and from a sufficient diversity of ecosystem types to capture the range of variability in on the ground settings. Table 4-4 is a gap analysis table provided by Defra to summarize information related to future research needs.

Table 4-4
Gap Analysis

	Target 14
Evidence on costs	*Strength of evidence*: medium *Extent to which further research is required*: medium
Evidence on current levels of expenditure	*Strength of evidence*: (not included in this phase of research) *Extent to which further research is required*: considerable
Other Aichi Targets	
Links to other Targets	Targets 3, 9, 10, 11, 12, 15, 18
Evidence on potential co-benefits	*Strength of evidence*: high *Extent to which further research is required*: some
Other policy areas	
Related policy areas outside of biodiversity	Coastal zone management, forest management, water quality, water infrastructure, rural health, indigenous communities, climate, transportation
Evidence on potential benefits to other policy areas	*Extent of potential benefits*: high *Extent to which further research is required*: some

[15] FY 2013 Budget Explanatory Notes for the U.S. Department of Agriculture.

4.7.3. Benefits of delivering the target

Benefits of wetland, forest, and coral reef restoration are well documented in terms of enhancing a wide range of ecosystem services associated with cleaning and purifying water, regulating floods, sequestering carbon, producing food and medicines, pollination and a wide range of cultural and recreational uses. We invite future analysts to consider the numerous studies that have attempted to quantify the ecosystem service values associated with restoration activities as economic arguments are often the most persuasive. As one example, Jenkins et al. (2010) determined that each hectare of wetlands restored in the Mississippi Alluvial Valley (MAV) could be expected to generate at least $1,435 to $1,486 per year in terms of carbon mitigation, nitrogen mitigation, and waterfowl recreation services. The magnitude of these benefits suggests that all costs to restore MAV wetland could be full recouped in just two years.

4.7.4. Funding opportunities and sources of funding

If our estimate of the amount of high impact road funding that could be canceled to achieve Target 14 goals is accurate ($108 billion a year) and politically if such funding could be diverted, it would more than offset the cost of these activities over the 2013 to 2020 period. As such, we strongly recommend linking funding for Target 14 activities to reductions in spending for unnecessary highways and other forms of public infrastructure.

There are many other programs at the international, national, state and local level to advance work on the activities we developed for Target 14. For wetland restoration, we take note of the International Corporate Wetland Restoration Partnership, which provides funding for both large and small-scale projects worldwide. Projects are selected and administered with the help of the Ramsar Convention on Wetlands or UNESCO's World Heritage Committee. The ICWRP site maintains a running list of illustrative case studies that demonstrate the far-reaching benefits of wetland restoration projects it finances.[16]

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[16] ICWRP case study fact sheets can be downloaded from: http://www.icwrp.org/.

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