

ENVIRONMENT

"True" Conservation Progress

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The field of biodiversity conservation is hampered by weak performance measurement and reporting standards (1). In other areas, such as the corporate world, weak reporting of performance is considered bad practice, if not illegal (2, 3). Although various evaluation frameworks for conservation programs have been suggested (4–7), few simple measures for unbiased reporting have been developed (8).

Credible performance measures should connect conservation outcomes to goals for public investment in conservation. Gains and losses must both be presented as an auditable conservation balance sheet (8), revealing the net benefit of conservation actions and policies reported against losses.

A major conservation performance metric in government state of the environment reports (9–14) is the size of the physical area protected, or the change in area protected. For example, South Africa reported that 6% of terrestrial habitat was contained within protected areas in 1999 (9); in 2001, North America reported an increase in land within reserves over time (13). However, these numbers provide no information on loss of habitat outside (or inside) reserved areas, or conservation opportunity costs of securing areas for conservation (15). Even when habitat loss is reported (11, 12), it is rarely possible to evaluate net conservation outcomes.

Performance Evaluation Metrics

Our performance evaluation metrics, F_{it} and M_i , may be used to assess the state of any conservation asset, such as vegetation types,

habitat types, or threatened species distributions. The proportions of an individual asset (i) secured or lost at time t (relative to some historical reference point) are denoted as s_{it} and l_{it} , respectively. Here, secured means that an action is implemented that maintains the biodiversity asset (e.g., legislated reservation, or actions that secure biodiversity, such as threat mitigation or habitat restoration). The term "lost" means biodiversity is degraded or destroyed (e.g., by land clearing, weed invasion, or waterway nutrient enrichment). Loss can occur on "secured land" if biodiversity components decline [e.g., (16)]. The area of asset i remaining available for conservation or loss at time t is given by $A_{it} = 1 - s_{it} - l_{it}$.

F_{it} gives a static measure of the net positive change in an asset relative to all changes that have occurred in that asset:

$$F_{it} = \frac{s_{it} - l_{it}}{s_{it} + l_{it}}, -1 \leq F_{it} \leq 1$$

If the amount of the asset secured is greater than that lost, F_{it} is greater than zero (see table, p. 44, asset B). F_{it} will be negative if the reverse is true (table, asset C). Overall conservation performance can be assessed from the average value of F_{it} across all assets:

$$\bar{F}_{it} = \frac{1}{N} \sum_{i=1}^N F_{it}$$

N is the total number of assets considered.

M_i measures a rate of change between two time points:

$$M_i = \frac{(s_{it_2} - s_{it_1}) - (l_{it_2} - l_{it_1})}{\left| (s_{it_2} - s_{it_1}) \right| + \left| (l_{it_2} - l_{it_1}) \right|}, -1 \leq M_i \leq 1$$

M_i is positive if an asset is protected at a greater rate than it is lost (table, asset B), and negative if loss exceeds protection (table, asset C). The average of M_i across all assets is

$$\bar{M}_i = \frac{1}{N} \sum_{i=1}^N M_i$$

F_{it} and M_i provide different information about conservation achievement. A limitation of having "simple" interpretable metrics is that a single metric may not cover all facets of

conservation performance. For example, if no loss has occurred for a given asset relative to some historical reference point, $F_{it} = +1$, even if a small amount of the asset is secured (see table, p. 44, asset G). Likewise, M_i gives a score of +1 if there is a gain in area secured without loss, irrespective of the magnitude of that gain (table, assets D, E, and G); it will also give a value of -1 if there is loss without gain, irrespective of the magnitude of that loss (table, assets F and H).

Presenting a single metric may fail to differentiate these and other situations; however, presenting both F_{it} and M_i along with A_{it} enables differentiation and thus honest and comprehensive reporting of all scenarios.

Case Study from Queensland, Australia

We demonstrate the utility of our metrics in expressing overall outcomes of conservation action (or inaction) within Queensland between the years 1997 and 2003. We use statistics on ecosystem loss through land clearing and areas secured through reservation as reported by the Environmental Protection Agency (17). Assets identified are 86 "land zones," where a land zone is an area delineated by characteristic geology, soil, and vegetation. We show the average for each metric across all land zones (blue bar in chart, p. 44, bottom) and individual metrics for a representative sample of 20 land zones (green bars).

Conservation areas were equivalent to ~5% of the available land in 2003 [(D) on chart, p. 44, red bar]; this total is the standard global metric. This measure, although small, provides a positive impression of the conservation of indigenous habitats. However, when metrics are used that account for both loss and reservation, they tell a markedly different story. They reveal that, overall, Queensland has lost more habitat than has been reserved [(A) on chart, $F_{it} \approx -0.7$ in 2003], and reservation had exceeded loss in only 37% of all land zones in 2003 [(B) on chart]. On average, loss had exceeded reservation in 2003 and had occurred at a higher rate between 1997 and 2003, across all land zones [chart (A) and (B)].

Although new reserves were established in 89% of land zones, further investigation by means of M_i indicates that loss rate exceeded rate secured within 55% of the land zones. To

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HYPOTHETICAL SCENARIOS

Asset (<i>i</i>)	Gain or loss (%)				F_{it_2}	M_i	A_{it_2} (%)
	s_{it_1}	s_{it_2}	l_{it_1}	l_{it_2}			
A	5	10	5	10	0.00	0.00	80
B	5	20	5	10	0.33	0.50	70
C	5	20	5	40	-0.33	-0.40	40
D	5	10	5	05	0.33	1.00	85
E	5	10	80	80	-0.78	1.00	10
F	0	0	5	20	-1.0	-1.00	80
G	5	6	0	0	1.0	1.00	94
H	5	5	5	10	-0.33	-1.00	85
I	10	5	5	5	0.00	-1.00	90
J	5	5	10	5	0.00	1.00	90

Hypothetical scenarios illustrating use of the metrics and the current proportion of land available for future conservation or loss.

further highlight the utility of reporting both F_{it} and M_i , we identify one land zone in Queensland where F_{it} and M_i show different net outcomes [see asterisk on chart, below, (A) and (B)]. F_{it} indicates that, overall, less loss has occurred than reservation for this land zone by 2003; however, M_i shows that loss has increased between 1997 and 2003, while reservation has remained unchanged. Large proportions of unprotected habitat persist in multiple land zones [chart, (C)], representing substantial opportunity for Queensland to improve conservation performance. Future changes in these metrics will indicate success or failure of the *Vegetation Management and Other Legislation Amendment Act of 2004*, which aims to phase out broad-scale vegetation clearing in the state (18).

Honest Reporting

We do not claim ours to be the best or only metric that could be developed: We merely aim to demonstrate that honest reporting is possible, can be simple and informative, and the current global standard of reporting gains, but not losses is unjustified and potentially misleading. We have demonstrated our metrics using a simplistic example where reservation indicates gain and habitat clearance indicates loss. These metrics could also be applied

to other forms of conservation gain (e.g., covenants or areas under sustained pest control) and degradation (e.g., invasion of a weed into a reserve). It is also possible to apply this to a situation where loss and gain are not absolute and information is available on change in asset quality (19). However, substantial extra effort would be required to coherently report on change in quality over large areas. Our metrics could also be extended to conservation prioritization by incorporating costs of recovery and probabilities of success of conservation actions. Incorporation of nonconservation objectives, such as local livelihoods (20), would require modification of these metrics.

Honest metrics of conservation achievements are essential to inform conservation

shareholders about the performance of their investments. In failing to mention the losses and opportunity costs of conservation investments, agencies reporting on conservation achievements are disclosing revenue rather than net profit and are being economical with the truth.

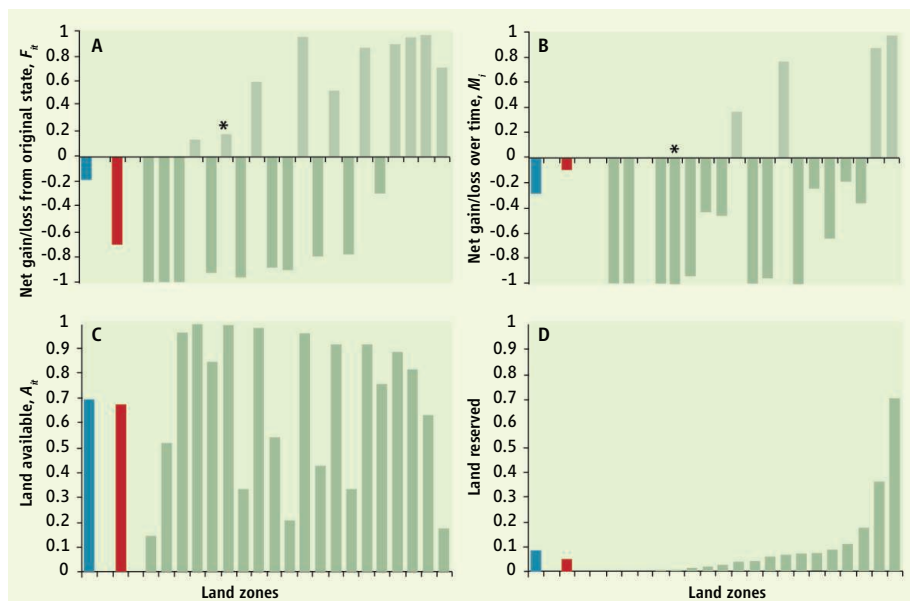
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Supporting Online Material

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Conservation performance in Queensland, Australia, based on reservation and land clearing between 1997 and 2003 (17). (A) F_{it} calculated for 2003, (B) M_i between 1997 and 2003, (C) the proportion of land available in 2003, and (D) the proportion reserved in 2003. The values for 20 land zones (green bars) are summarized by the mean (blue bar) and the value of each measure based on the total reservation and loss across all land zones in Queensland (red bars, combined to allow comparison with the standard metric of the total reservation area). *Examples in which the metrics lead to different conclusions.