Figure 9.2.1.
Problem feedback loop analysis

Nature of loops

There has long been recognition of how one problem can aggravate another and of how several Problems (or Strategies) can reinforce each other. The UIA data register many relationships between Problems in complex networks. Clearly such relationships may form chains or pathways linking many Problems. But hidden in the data as presented is also the existence of chains that loop back on themselves. The data then offers a unique opportunity to identify such feedback relationship loops or cycles through which several Problems constantly reinforce one another.

A "loop" represents a description of a chain of consequences that produces a dynamic outcome by feeding off itself (positive feedback = "vicious" or "virtuous" loops), or by controlling itself (negative feedback). Typically a feedback loop will be an important strategic issue in its own right. The purpose of detecting feedback loops is to raise the level of analysis of individual issues to a higher, systematic level. It is a technique that has the potential to add extra meaning to basic data, particularly relevant for policy makers (one significant user group for this product) and others concerned with understanding the interrelationships and root causes of environmental problems, notably those relevant to biological conservation.

A self-reinforcing ("vicious") problem loop, then, is a chain of Problems, each aggravating the next, and with the last looping back to aggravate the first in the chain. An example is:

Man-made disasters →Vulnerability of ecosystem niches → Natural environment degradation → Shortage of natural resources → Unbridled competition for scarce resources → Man-made disasters.

Such cycles are "vicious" because they are self-sustaining problem cycles. Organisational strategies and programmes that focus on only one problem in a chain may fail because the cycle has the capacity to regenerate itself. Individual "vicious problem cycles" also tend to interlock, forming tangled skeins of interlinked global Problems which implicate single environmental problems in chains and complexes of multi-sectoral issues. Without the means to untangle the relationships, the response to a conservation challenge may be ineffective, self-defeating or, even, harmful. In some cases the relationship may be a feedback loop in its own right where A influences B and B influences A – creating a nested negative feedback loop within a positive feedback loop

It is important to recognise that it is precisely through the detection of such loops that attention can be drawn to defects in the pattern of relationships in the data. It is possible for some loops to be the result of incorrect relationships rather than being representative of genuine feedback, and so "accidental" loops appear. Detection of loops is therefore in the first place an editorial tool for hyperlinkage within a relational database. It raises questions as to the appropriateness of certain links which otherwise may go unquestioned. It also sharpens the discussion on how distinctions are made, using verbal categories and definitions, and how system boundaries are drawn grouping what is represented in this way. The results indicate this is a very interesting area for further exploration.

Visualization tools that portray loops can then be adapted to assist editorial and error detection processes. The key issue here is speed of detection and generation of loops.

Loop analysis

Experiments in 1995 gave rise to the results in the table below. It was concluded that the procedure had promise but needed refinement, notably to detect Problems erroneously excluded from loops, as well as loops excessively connected to a single problem.

Progressive Refinements of Problem Loops

	Prior to Project	INFO2000 Project			
	1995	1999	1999	2000	2000
	Column 1	Column 2	Column 3	Column 4	Column 5
Machine	386/486	486	Pentium III	Pentium III	Pentium III
Processing Time	many weeks	Some days	37 hours	12.5 hours	500 hours
Chains tested	9,519,722	15,000,000	46,474,882	16,091,877	1,239,769,768
Profiles			6,891	1,217	12,397
2-Loop	-				5
3-Loop	35				173
4-Loop	115				230
5-Loop	527				473
6-Loop	3,058				1,163
7-Loop	3,568				3,473
8-Loop	excluded	excluded	excluded	excluded	10,600
9-Loop	excluded	excluded	excluded	excluded	35,438
Total	**7,303**	**6,000**	**15,958**	**8,253**	**51,555**

Overview of loop patterns for problems that "Deforestation" aggravates

Table 1 shows a chain of impacts. Maximum number of loops currently listed = 15 (of 49).
- o Each cell is a Problem profile.
- o Each row is a loop (starting from column 1).
- o Column 1 items impact on column 2 items; column 2 items impact on column 3 items; etc.
- o Last column items loop back to impact on those in the first column.
- o The pattern is helpful in highlighting questionable links and errors.

Table 2 gives the names of the problems in the cells of Table 1. Items are listed in decreasing order of frequency of occurrence in Table 1.

These tables were adapted from: http://www.uia.org/projects/finarept/image21.htm and http://www.uia.org/projects/finarept/image20.htm

Table 1

Table 1	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8	Col 9
Loop 1	A	AV	AC	AB	AE	Q	P	K	M
Loop 2	A	AC	AB	AE	Q	P	K	M	
Loop 3	A	AC	AB	AK	AE	Q	P	K	M
Loop 4	A	AC	AB	AK	Y	Q	P	K	M
Loop 5	A	C	L	AJ	J	H	F	B	
Loop 6	A	C	L	AA	J	H	F	B	
Loop 7	A	C	L	J	H	F	B		
Loop 8	A	C	L	J	H	AU	AT	N	D
Loop 9	A	C	L		W	T	S	R	
Loop 10	A	C	L		W	T	AI	S	R
Loop 11	A	C	L		W	T	X	V	B
Loop 12	A	C	O	Z	AH	AS	AR	E	B
Loop 13	A	C	O	Z	AH	AQ	AP	AD	I
Loop 14	A	C	O	Z	AG	AO	AN	AF	U
Loop 15	A	C	O	Z	AG	AM	AL	G	B

Table 2

A	379	Deforestation
B	241	Environmental pollution
C	128	Global warming
D	25	Forest decline
E	24	Urban slums
F	21	Toxic metal pollutants
G	20	Indiscriminate economic development
H	18	Marine dumping of wastes
I	17	Unsustainable population levels
J	13	Marine accidents
K	13	Failure of green politics
L	12	Bad weather
M	12	Insufficient environmental legislation
N	11	Acidic precipitation
O	9	Inhospitable climate
P	9	Restrictive environmental policies
Q	9	Doom-mongering
R	8	Environmental hazards from logging
S	8	Foreign exchange reserve shortages
T	8	Burden of servicing from foreign public debt
U	7	Environmental warfare
V	7	Criminal offences against the environment
W	7	Instability of the commodities trade
X	6	Social hardships of economic reform
Y	6	Risk of eco-accidents
Z	4	Deficiencies of developing countries

However, loops are relatively rare in chains of problems. During 1999, some 15 million chains of Problems were searched to detect those that looped back on themselves within 7 links maximum. Some 6,000 loops were detected and were scanned for potential errors and hyperlink redundancy. The results of this work were integrated into the facilities offered to web users via the UIA website. Loops were flagged in the hit index and so became available to web users for the first time in beta test mode in October 1999. This web module was delivered in beta mode at http://www.uia.org/data.htm in early 1999 and has been continuously upgraded on numerous occasions since that time. Later in the year, as a result of third-party contribution to *Java* graphics capability, loops were visualised as an integral feature of the bespoke *Java* spring mapping facility which is the basis for a number of figures in this section.

The final stages of the loop detection and visualization activity were completed towards the end of 1999. First, the loop detection program was run in batch mode for all Problems (except the most detailed and minor). The result was 15,958 feedback loops. Loops that involved the more detailed and minor Problems were edited at source to correct anomalous linkages. The logic behind this is that it is inappropriate for broad and detailed Problems to be directly aggravating narrow and minor Problems, and vice versa; this connection is best shown through hierarchical relationships where “suites” of problems are so aggravating. The most common remedy was to remake the link higher up the hierarchy of the detailed or minor Problem.

This activity reduced the number of loops to 5,873. To further eliminate errors, entries involved in more than 80 loops were carefully edited; redundant and anomalous links were corrected. This activity reduced the number of loops to 2,675. It is believed that this list effectively represents “keystone” biodiversity issues -- problems that are implicated in many negative feedback systems concerning the natural environment.

Finally, the loop detection program was run again for the entire Problems database. The resulting 51,555 loops were subjected to the error tests developed in previous iterations. A total of 9,315 Problem loops were uploaded onto the website.