Using integrated assessment to develop policy options – trade, land use and biodiversity

A case study of the sugar industry in Jamaica

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Abstract

Purpose – The purpose of this paper is to report on the application of integrated assessment (IA) methods to examine the impact of policy changes on Jamaica's sugar industry; also the potential implications for the economy, employment, society, environment and biodiversity.

Design/methodology/approach – The project applied the integrated assessment (IA) methodology described in the United Nations Environment Programme UNEP-WCMC/ETB 2009 document "Biodiversity in Integrated Assessment of Trade Policies in the Agriculture Sector".

Findings – Jamaica's sugar industry has survived because of European Union subsidies, which are now being phased out. The Government therefore decided to divest the industry and refocus it on ethanol production to reduce oil imports. The plan failed, because it depended on factors which were not under the Government's control; specifically, external trade regimes and tariffs. The application of IA identified several possible future scenarios for the industry and developed a solution that would achieve a range of goals, moving away from extensive, low-value forms of agriculture to intensive, high-value forms, increasing revenue, profits and skill transfer, while simultaneously reducing environmental impact.

Research limitations/implications – The main limitation is the specific focus on one traditional, uncompetitive industry, so results have to be generalized with caution to other sectors with different characteristics.

Originality/value – This paper draws on a much longer technical report titled "The Sugar Industry in Jamaica" written by Anthony Clayton, K'adamwe K'nIfe and Andrew Spencer for the United Nations Environment Programme, Division of Technology, Industry, and Economics, Economics and Trade Branch in 2009. This paper focuses on the main conclusions with regard to the use of IA, and updates the findings, demonstrates the utility of IA methods and shows how Governments can use IA to avoid serious, costly policy failures, and increase the chances of successful outcomes.

Keywords Integrated assessment, Trade, Land, Biodiversity, Government policy, Sugar industry, Jamaica
Paper type Case study

The Convention on Biological Diversity (CBD), established in 1992, defines biodiversity as comprising the variety of life on Earth; the combination of diverse life forms and their various interactions with each other and with the physical environment that has made the planet habitable for humans (CBD, 2006). In 2002, the Conference of the Parties of the convention adopted a strategic plan "to achieve, by 2010, a significant reduction of the current rate of biodiversity loss at the global, regional and national level, as a contribution to poverty alleviation and to the benefit of all life on Earth". In order to assess progress towards the 2010 biodiversity target, the Conference of the Parties also established supporting goals and targets and identified indicators for evaluating biodiversity status and trends. Jamaica is a signatory to the CBD.

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One reason for concern is that biodiversity loss disrupts ecosystem functions, making ecosystems more vulnerable to shocks and disturbances, less resilient and less able to supply humans with necessary services. The damage to coastal communities from floods and storms, for example, can increase dramatically where protective wetland habitats have been lost or degraded. According to CBD (2006), "Garnering the political will to halt ecosystem degradation will depend on clearly demonstrating to policy makers and society at large the full contribution made by ecosystems to poverty alleviation efforts and to national economic growth more generally".

Jamaica, like many other developing countries, needs to encourage enterprise and stimulate economic development and growth in order to raise the average standard of living, but must now find ways to do so that also protect and maintain its biodiversity. Most of Jamaica has been subject to settlement and development, but it is still biologically diverse, with many endemic species. However, this biodiversity is now under threat (National Environment and Planning Agency (NEPA), 2002). The sugar industry, which does significant damage to rivers and reefs, has only survived because of European Union (EU) subsidies, which are now being phased out. The industry is therefore being prepared for divestment, and refocused on ethanol production to reduce oil imports. It appears that this plan may have already failed, because it depended on factors (external trade regimes and tariffs) which are not under Jamaica's control, so a new policy is urgently needed.

This project applied the integrated assessment (IA) methodology described in the United Nations Environment Programme UNEP-WCMC/ETB document "Biodiversity in Integrated Assessment of Trade Policies in the Agriculture Sector" to examine the impact of policy changes on Jamaica's sugar industry, and the implications for the economy, employment, society, environment and biodiversity.

The primary research involved an extensive series of interviews and site visits. The secondary research involved a review of the literature: surveys, studies, technical assessments and reports. The project examined the main social, economic, historical and path-dependency, trade-related, technological, institutional, environmental, developmental, energy, resource and environmental factors involved. The study identified several possible future scenarios for the industry, and developed a solution that would achieve a range of goals, moving away from extensive, low-value forms of agriculture to intensive, high-value forms, increasing revenue, profits and skill transfer, while simultaneously reducing environmental impact. It also presented policy options for achieving optimal attainable outcomes and for anticipating and mitigating any serious negative social or environmental effects arising from extensive changes in land use, with particular regard to the implications for Jamaica's biodiversity.

IA

According to United Nations Environment Programme (UNEP) (2007), "Integrated assessment is used to evaluate the environmental, social and economic impacts of trade policies, providing policy makers and trade negotiators with information necessary for decision making that supports sustainable development". It is an interdisciplinary exercise, which combines the interpretation and communication of expertise from various relevant disciplines in a way that highlights the economic, social and environmental impacts associated with a policy. The methodology have six key stages, as follows:

(1) understanding the policy context;

(2) determining the focus;

(3) assessing the impacts;
(4) developing policy recommendations;
(5) implementing policy recommendations; and
(6) monitoring and evaluating the implementation of the recommendations.

Understanding the policy context and determining the focus are considered to be *ex ante* IA, while implementing policy recommendations and monitoring and evaluation are considered to be *ex post* IA with the policy being revised on the basis of the monitoring results. Appendix 1 provides more detail on the IA approach.

The policy context

Sugar was introduced to Jamaica as early as 1494 (Lawson, 1971; Ehrlich, 1970). Jamaica was the world's largest sugar exporter throughout the eighteenth and early nineteenth centuries, supplying Britain, the USA and Europe. Today, however, Jamaica's sugar industry has costs of production that are among the highest in the African, Caribbean and Pacific (ACP) group of countries. The industry suffers from a number of structural and institutional weaknesses (Thornhill, 2007), including run-down capital assets, a crumbling road network that places logistical constraints on the economic transportation of harvested cane, shortages of field workers and a high turnover of professional staff. In addition, Jamaica is a small island, which permanently prevents Jamaica from attaining the economies of scale of the world's large sugar producers, such as Brazil and Australia[1].

Over 130 countries now produce sugar, and world sugar production was nearly 143 million tonnes in 2002, so Jamaica's share of world production is now negligible (about 0.1 per cent)[2]. There has been an equally dramatic reduction in the number of estates and distilleries (from 670 in 1832 to seven in 2006), the tonnage of sugar produced has slumped (from 514,450 in 1965 to 124,206 tonnes in 2005), the contribution to export earnings has fallen (from 49 in 1952 to 1.8 per cent in 2006) and the contribution to GDP has fallen (from 9 in 1953 to 0.8 per cent in 2006). Jamaica's sugar industry has continued to survive over the last three decades largely because of the sugar protocol, set up in 1975 between the EU and the 18 ACP sugar-producing countries, which gave these countries access to the EU market and guaranteed, preferential prices (which averaged three times the world price) for an indefinite duration (Thornhill, 2007; Mitchell, 2005). However, the sugar protocol was costly, did little to encourage development and was the subject of repeated complaints at the WTO, so the EU announced in September 2007 that the arrangements of the sugar protocol could no longer be maintained, this would be replaced by a new Economic Partnership Agreement (EPA).

The focus

With the emergence of the EPA the Jamaican government was forced to adjust its modus operandi in the sugar industry. In carrying out the assessment it was critical to determine the specific issues to be considered, including this emerging trade policy; the potential impact of changes in trade regimes on the Jamaican sugar industry, possible future scenarios and policy options, and the associated implications for the environment and biodiversity. This made it possible to indentify the social, economic and environmental implications of each of the most likely future scenarios for the industry and to develop a model that would give a better array of social, economic and environmental outcomes for Jamaica.

The impact

On 1 January 2008 the traditional trade preferences afforded by the EU to the Caribbean members of the ACP were replaced by a single EPA. As part of a transition to open markets and reciprocity (albeit with differential liberalization timetables; immediate removal of tariffs by the EU and up to 25 years by the Caribbean states) the price regime for sugar supplied by the ACP countries to the EU started to undergo phased price reductions as part of a managed transition to market prices. Without significant change, it seemed unlikely that the Jamaican sugar industry could survive.

The Planning Institute of Jamaica (PIOJ) report "Jamaica country strategy for the adaptation of the sugar industry 2006-2015" argued that there would be significant socio-economic consequences for Jamaica. These included the loss of €24 million per annum in foreign exchange export earnings by 2010, with cumulative losses of €184 million over the ten years from 2006 to 2015, with implications for the medium-term socio-economic targets; the exit of small cane farmers from the industry, which might lead to the shut-down of raw sugar production at a number of government-owned estates consequently resulting in a loss of direct employment; losses in producer and household income, significant reductions in the purchases of capital goods and intermediate goods and services as well as loss of government revenue; increased migration from rural to urban areas, the growth of informal human settlements (squatter communities) around cities, increased poverty levels, the loss of social benefits provided by sugar estates, and increased crime and health problems in the regions most affected.

The government therefore decided to diversify the products currently being derived from sugar cane and privatize the industry (PIOJ, 2006, pp. 8-9). The diversification plan focused on ethanol, partly because Jamaica is dependent on imported crude oil for over 90 per cent of its energy needs, so any displacement of demand for gasoline would help to reduce the negative balance of payments. This gives three possible future scenarios:

(1) The plan will succeed, in which case there will be a significant increase in the land area utilized for cane production for ethanol. This is likely to have negative consequences for river and coastal water quality, although the contribution to mitigating climate change would have to be offset against these impacts.

(2) The diversification plan will not succeed, in which case much of the land might become available for other forms of land use, such as housing, tourism or forestry. Alternatively, it might revert to scrub. Some options could be environmentally positive, but much would depend on the management of the process of change.

(3) The third possible future (which was the primary recommendation of the study), multi-objective optimization, was developed by the project team to demonstrate a possible solution that could achieve a range of developmental goals, moving away from extensive, low-value forms of agriculture to intensive, high-value forms, increasing revenue, profits and skill transfer, while simultaneously reducing environmental impact.

Each scenario has significant implications for environmental protection and biodiversity conservation.

Policy recommendations

The recommended scenario of a multiple objective optimization formed the context and basis for policy recommendations. Jamaica has been severely impacted by a number of recent developments, including the sharp rises in the price of oil and grains. These highlighted Jamaica's current lack of both energy and food security. The loss of trade preferences is also exposing the uncompetitive nature of the sugar industry. A hybrid, multi-objective plan might therefore have a better chance of success. For example, a managed, partial diversification of the cane lands into a combination of more intensive, higher-value uses might include the following elements:

- Value-added agriculture, including food (including yam, potatoes, cassava, dasheen, breadfruit and other complex carbohydrates), and high-value plant extracts (such as oleoresins and flavonoids) for export. The latter would involve a departure from mass commodity markets, which involve competition based on price, and redirection towards niche markets, which involve competition based on quality and marketing; are typically low-volume, but offer better margins.
- Mixed development, with a mosaic of interconnected land uses, including agriculture, new housing developments, light industrial plants and green spaces.
- Tourism, with a major expansion of conventional recreational tourism, eco-tourism and heritage tourism, and health and retirement tourism.

With regard to the first element, one potential value-added market was the subject of a scoping study by Clayton and Staple-Ebanks (2002). This focused on the development of nutraceuticals and functional foods, defined as those purchased primarily because they deliver an additional health or nutritional benefit (Leighton, 2000). The market was valued at US$24.2 billion in 2003, with Japan accounting for over half of the total (LFRI, 2004). This kind of high-value market has the potential to demand-pull a range of new business opportunities in agriculture and agro-processing for farmers and processors in Jamaica. Diversification into the production of oleoresins, flavonoids and similar high-value products would create higher economic returns and generate employment opportunities in the rural areas, thus easing the transition. The value of the exports would be significantly higher while the weight would be significantly lower, thus improving value-to-weight ratios, largely eliminating the transport cost penalty of island production and increasing profit margins. The higher costs of production in Jamaica would not be a serious impediment, as the ingredient cost in a nutraceuticals product can be less than 1 per cent of the final consumer price. India can produce ginger, for example, at about one-seventh of the Jamaican cost, but this advantage becomes less important when it has relatively little impact on the final price. Another advantage is that customers in the nutraceuticals and functional foods industry typically require oleoresins or other processed fractions, standardized and refined to a high level of purity before export. This means that both production and extraction stages would be based in Jamaica, capturing the value-added.

With regard to biofuels, a more durable option might be to source initially from Brazil, pending the development of third-generation solutions (such as algal biodiesel) that do not create the same demands for land or water.

With regard to food security, former sugar lands could be used to produce alternatives to imported wheat and rice, including complex carbohydrates such as yam, potatoes, cassava, dasheen and breadfruit; these are healthier alternatives.

This combination would achieve a range of developmental goals, moving away from extensive, low-value forms of agriculture to intensive, high-value forms, increasing revenue, profits and skill transfer, while simultaneously reducing environmental impact.

The fate of the sugar industry has significant social, economic and environmental implications. The third scenario indicated that a combination of positive economic, social and biodiversity outcomes was achievable. Specifically, it would stem losses in the industry, generate export revenues and create employment. It would also reduce the spread of informal settlements, increase the percentage with proper housing and land titles, reduce the rate of violent crime, decrease poverty and improve health status. The environmental implications are even more profound. It would reduce pollution of inland and coastal waters with agrochemicals and silt, improve coral reef health, reduce air pollution, save endangered species, reduce the rates of soil erosion, foster greater tree cover, especially mangroves and plains and facilitate carbon sequestration. Appendix 2 provides data on the various social, economic and environmental/biodiversity indicators through which the performance of the scenario can be evaluated in the future; as well as data on the flora and fauna of Jamaica potentially threatened by current economic activities.

Findings and conclusion of research

The research found that:

- Most of Jamaica has been subject to settlement and development, but it is still rated fifth in the islands of the world for endemic plants. There is also a high level of endemism for snails, crabs, amphibians, reptiles and land birds. Many wild species make significant contributions to Jamaica's economy, but some are now endangered.
- The most rapid loss of biodiversity is incurred when land is first converted for agricultural production. Sugar was introduced to the Caribbean in the late fifteenth century, so the most rapid loss was probably incurred when the industry was expanding throughout the seventeenth and eighteenth centuries. The environmental impacts associated with the industry today are therefore determined primarily by its routine operations.
- The main impacts are caused by surges of cane mill effluents which are sometimes discharged directly into streams and end up in coastal waters, along with run-off agrochemicals. The effluents are high in organic matter, and can also include heavy metals, oil, grease, cleaning agents and alcohol by-products. This reduces oxygen levels in the water, killing fish and crustaceans, and promoting algal blooms, which damage the coral reefs.
- These impacts are exacerbated by long-term under-investment in the industry, as the plants are old, badly maintained and inefficient, with higher economic and environmental costs. Other factors include poor management, lack of environmental awareness and weak environmental regulation.

Jamaica was once the largest sugar exporter in the world, but the industry is now uncompetitive and accounts for just 0.1 per cent of world output. It has survived because of EU subsidies, which are being phased out. It is now being prepared for divestment, and focused on ethanol production to reduce oil imports. It is not clear whether this plan will succeed; it depends on factors (external trade regimes and tariffs) which are not under Jamaica's control.

There are several possible future scenarios for the industry. The current government plan might succeed, in which case the "idle" cane lands will be brought back into production, or the plan will fail, in which case land will revert to scrub or become available for development, forestry or other forms of agriculture. Each option has significant implications for environmental and biodiversity conservation. Other, potentially better policy options are possible; the example given here would achieve a range of developmental goals by integrating social, economic and environmental objectives. This would involve a transition from extensive, low-value agriculture to intensive, high-value production, increasing revenues, profits and skills, while simultaneously reducing environmental impact.

The research unearthed a number of concerns for the Jamaican agriculture sector and the sugar industry in general. Most importantly it suggests a way forward for the country, which would improve the quality of life of the people and stimulate growth in the economy while maintaining the biodiversity of the country.

A major concern, however, is, there are serious gaps in the data on Jamaica's biodiversity, although some preliminary work has been done. A key element of an implementation phase would include the construction of a database and set of bio-indicators, so that future policy decisions could be better informed in this regard.

Notes

1. Source: EU Projects: Rural Development. Accompanying measures to sugar protocol countries – 2007.
2. Source: UN Food and Agriculture Organization; Economic and Social Department.

References

Clayton, A. and Staple-Ebanks, C. (2002), *Nutraceuticals and Functional Foods: A New Development Opportunity for Jamaica: Market-Scoping Study: Technical Report for the National Commission on Science and Technology*, Environmental Foundation of Jamaica (EFJ), Kingston.

Convention on Biological Diversity (CBD) (2006), "Global biodiversity outlook", Secretariat of the Convention on Biological Diversity, Montreal, March.

Ehrlich, A.S. (1970), "East Indian cane workers in Jamaica", doctoral thesis, The University of Michigan, Ann Arbor, MI.

Haynes-Sutton, A. (1999), "Sector assessment report: terrestrial flora, in National Biodiversity Strategy and Action Plan 1999, in Jamaica's environment 2001", Statistical Institute of Jamaica, NEPA.

Lawson, S. (1971), "Jamaica's sugar industry: an inquiry into the social and economic repercussions of a declining industry", thesis, New York University, New York, NY.

Leatherhead Food Research Institute (2004), "LFI food news", Leatherhead Food Research Institute, Leatherhead, 2 June.

Leighton, P. (2000), "Up and coming markets: opportunities and issues from a Darwinian perspective", *Nutraceuticals World*, Vol. 40, available at: www.nutraceuticalsworld.com/issues/2000-10/view_features/up-and-coming-markets-2000-10-01-00-00-00/

Mitchell, D. (2005), "Sugar in the Caribbean: adjusting to eroding preferences", World Ban Policy Research Working Paper No. 3802, World Bank, Washington, DC.

National Environment and Planning Agency (NEPA) (2001), "Terrestrial fauna, assessment report for the National Biodiversity Strategy and Action Plan 1999, in Jamaica's environment 2001", Kingston.

National Environment and Planning Agency (NEPA) (2002), *Towards a National Strategy and Action Plan on Biological Diversity in Jamaica*, NEPA, Kingston, Jamaica.

Planning Institute of Jamaica (PIOJ) (2006), "Jamaica country strategy for the adaptation of the sugar industry 2006-2015", *Planning Institute of Jamaica*, Jamaica.

Thornhill, S. (2007), "Safeguarding the benefits of the ACP – EU sugar protocol in the context of the EPA negotiations", final draft report.

United Nations Environment Programme (UNEP) (2007), *Incorporating Biodiversity into Integrated Assessment of Trade Policy in the Agriculture Sector*, Geneva.

Woodley, J.D., De Meyer, K., Bush, P., Ebanks-Petrie, G., Garzon-Ferreira, J., Klein, E., Pors, L. and Wilson, C. (1971), "Status of coral reefs in the south-central Caribbean", in Wilkinson, C. (Ed.), *Status of Coral Reefs of the World: 1998*, Australian Institute of Marine Science, Townsville.

Appendix 1

Stage	Description	Purpose	Actions
A	Understanding the policy context	To identify the rationale for conducting the integrated assessment and to clarify the general policy context	A1. Identify the overall purpose A2. Review the proposed policy and policy-making context A3. Identify participants and stakeholders A4. Identify and review available information
B	Determining the focus	To identify the specific issues to be considered in the integrated assessment	B1. Determine the parameters B2. Develop a conceptual framework B3. Identify priority sustainability issues
C	Assessing the impacts	To analyse economic, social and environmental impacts of various policy options	C1. Identify criteria relevant to the main issues C2. Develop economic, social and environmental indicators C3. Determine the baseline C4. Identify policy options including most likely scenario to be reviewed C5. Analyse impacts using appropriate tools and techniques
D	Developing policy recommendations	To interpret outcomes of integrated assessment and influence policy decisions	D1. Finalize conclusions and balance outcomes D2. Develop policy recommendations D3. Select and communicate policy recommendations

(*continued*)

Table AI.
The integrated assessment process

Stage	Description	Purpose	Actions
E	Implementing policy recommendations	To translate policy recommendations into action	E1. Identify actions for implementation E2. Establish a monitoring and feed-back mechanism
F	Monitoring and evaluation	To refine policies implemented following outcomes of the integrated assessment	F1. Monitor impacts F2. Review and revise policy recommendations

Table AI.

Source: IA Manual, UNEP (2007)

Appendix 2. Baseline indicators: flora and fauna in Jamaica

The fate of the industry should become clear over the next year. The following indicators will be used to track the outcome.

Indicator	Baseline (2008)	S1: plan works	S2: plan fails	S3: alternative plan
Economic				
GDP at PPP	$21.57 billion			
GDP at f/x rate	$13.47 billion			
GDP growth	0.8%			
GDP composition/sector				
Agriculture	5.2%			
Industry	32.9%			
Services	61.8%			
Labour force total	1.26 million			
Labour force/sector				
Agriculture	17%			
Industry	19%			
Services	64%			
Unemployment rate	10.1%			
Household income				
Lowest 10%	2.1%			
Top 10%	35.8%			
Gini coefficient	0.45			
Government budget				
Revenues	$4.16 billion			
Expenditure	$4.84 billion			
Deficit	$0.68 billion			
Public debt	124.1% GDP			
Inflation rate	22.5%			
Commercial lending rate	17.2%			
Current account balance	−$2.448 billion			
Governance				
TI Corruption Perception Index (CPI)	3.3/10			
TI CPI world rank	84/180			

Table AII.
Indicators: baseline and scenarios

(*continued*)

Indicator	Baseline (2008)	S1: plan works	S2: plan fails	S3: alternative plan
Energy				
Electricity production	7.04 billion kWh			
Electricity consumption	6.1 billion kWh			
Energy density (kWh/GDP)	0.45			
Oil production	0 bbl/day			
Oil consumption	73,280 bbl/day			
Oil imports	71,280 bbl/day			
Oil exports	1,535 bbl/day			
Ethanol production (gallons)	40 million (potential)			
Ethanol imports	n/a			
Ethanol exports	n/a			
Total CO^2 emissions (tonnes)	2,743,000 (1996)			
Per capita CO^2 (tonnes)	1.10 (1996)			
Industry specific				
Employment (estates)	6,000			
Employment (small)	32,000			
% employment	2.4			
Foreign exchange income	$75 million			
% f/x income	1.8			
% of agricultural exports	36			
% of all export earnings	6			
% GDP	0.8			
% agricultural land	30			
% permanent crop land	41			
Sugar housing (units)	n/a			
Social				
% below poverty line (all)	20			
% below poverty line (rural)	25			
Urban-rural drift				
Urban growth 2000-2015	1.7%			
Rural growth 2000-2015	−0.4%			
Informal settlements	700			
Squatters (% population)	15-35			
Homicides	1,611			
Homicide rate per 100,000	57.4			
Life expectancy at birth total	73.59			
Male	71.88			
Female	75.38			
School enrolment total	87.9%			
Male	84.1%			
Female	91.6%			
Education expenditure	5.3% GDP			
Health				
Obesity total	25.2%			
Males	12.0%			
Females	37.5%			
Hypertension (number, 15-74)	450,000			
Diabetes (number, 15-74)	150,000			

(*continued*)

Table AII.

Indicator	Baseline (2008)	S1: plan works	S2: plan fails	S3: alternative plan
Environmental				
Live coral cover (average)	16.67%			
Water pollution incidents	n/a			
BOD in sample river	n/a			
Endangered birds	7			
Endangered mammals	5			
Endangered reptiles/amphibians	12			
Endangered plants	462			

Table AII.

	Endemic	Introduced	Found elsewhere	Total	Vulnerable	Endangered	Critically endangered
Mammals excl bats[a]	1	5	0	6	2[b]		
Bats	2	0	19	21	2	1	
Land birds[c]	30	10	86	126	3	1	3[d]
Shore and sea birds	1	0	38	39			
Reptiles	33	0	10	43	7	2	3[e]
Amphibians	22	0	0	22			
Ants	6	0	53	59			
Butterflies	20	0	113	133	1	4	
Fireflies	45	0	3	48			
Freshwater fish	6	–	–	~200	2[f]		
Jumping spiders	20	0	6	26			
Square back crabs (*Grapsidae*)	9	0	0	9			
Land snails	514	0	39	553[g]			
Rotifers	<21	–	–	211			
Total	730	–	–	1,496	17	8	6

Notes: [a]The hutia (Jamaican coney) is the only mammal now living in Jamaica that was not introduced. The Jamaican rice rat is extinct. The introduced wild species are mongoose, deer, black rats, brown rats and mice. There are also feral pigs, goats, dogs and cats; [b]the vulnerable mammals are the West Indian manatee, the hutia and three species of bat; [c]the data is for birds that breed in Jamaica. The total observed in Jamaica is about 280; [d]the critically endangered birds are the Jamaican petrel, the ring-tailed pigeon and the Jamaican pauraque (probably extinct); [e]the critically endangered reptiles/amphibians are Jamaican iguana, the hawksbill turtle and the black racer (probably extinct); [f]the two fish species considered rare/vulnerable are both endemic; and [g]data on most of the invertebrates is not available

Source: NEPA (2001)

Table AIII.
Fauna in Jamaica

There are extensive gaps in the data. For example, there are several types of plants, including grasses, mosses and fungi, where the number of species is unknown. There are also disparities between the few available data sources. According to Jamaica's Conservation Data Centre database, at least 221 endemic species are classified as "critically imperiled" or "especially vulnerable to extinction". The World Resources Institute summary for Jamaica is as follows:

Higher plants

Total known species (1992-2002): 3,308

Number of threatened species (2002): 206

Type of plant	Known	Endemic	Endangered
Angiosperms (flowering plants)	3,006	829	427
Bromeliads	60	22	
Orchids	230	66	
Cacti	20	10	
Palms	10	7	
Gymnosperms (conifers and cycads)	6	3	5
Ferns	609	82	30
Slime moulds	74	2	
Totals	4,015	1,021	462

Source: Haynes-Sutton (1999)

Table AIV.
Flora in Jamaica

Mammals
Total known species (1992-2002): 24
Number of threatened species (2002): 5
Breeding birds
Total known species (1992-2002): 75
Number of threatened species (2002): 12
Reptiles
Total known species (1992-2003): 49
Number of threatened species (2002): 8
Amphibians
Total known species (1992-2003): 24
Number of threatened species (2002): 4
Fish
Total known species (1992-2003): 200
Number of threatened species (1992-2002): 1

The general conclusions, however, are similar; Jamaica still has a relatively high level of biodiversity and endemicity, but a number of species are now extinct, others are threatened, and there are extensive gaps in the available information.

The impact on Jamaica's coral reefs

In the late 1970s a survey of nine reefs on Jamaica's north coast found live coral cover averaging 52 per cent at 10 m depth. In 1998, areas once dominated by corals at Discovery Bay and in the Montego Bay Marine Park had live coral cover reduced to 10 and 14 per cent, respectively (Woodley *et al.*, 1998). In 2005, a survey of 15 sites found live coral cover ranging from 0 to 34 per cent, indicating that most of Jamaica's reefs were now unhealthy or dead.

The table below shows the percentage of hard coral cover on selected sites between 2001 and 2005. In most cases, live cover was greater at deeper depths. This suggests that degradation in these areas is due primarily to the effects of human disturbance, which are generally greater in shallow waters, rather than natural causes. These impacts include over-fishing, and the run-off of sediment, nutrients and chemicals from agricultural areas or sewage systems, which encourage the overgrowth of corals by algae. In some sites, coverage of reefs by fleshy macroalgae increased from 4 to 92 per cent.

Site	2001 Depth (m)	2001 Cover (%)	2002 Depth (m)	2002 Cover (%)	2003 Depth (m)	2003 Cover (%)	2004 Depth (m)	2004 Cover (%)	2005 Depth (m)	2005 Cover (%)
Bloody Bay	3	25.00	3	9.38	3	21.88	6	22.50	4	15.63
Westmoreland										
Negril	10	25.00	10	12.50	10	18.13	10	24.38	10	30.00
Ireland Pen	3	5.00	3	8.75	3	3.75	–	–	4	3.13
Westmoreland										
Negril	10	13.75	10	13.13	10	9.38	–	–	8	15.63
El Punto Negrilo	3	22.50	3	8.13	3	6.88	3	20.00	4	6.25
Hanover										
Negril	–	–	10	16.88	10	17.50	10	29.38	10	32.50
Little Bay	–	–	3	8.75	3	15.00	3	16.88	5	9.38
Hanover										
Negril	–	–	10	18.13	10	21.88	7	11.25	8	32.50
Pigeon Island	–	–	–	–	3	13.75	2	22.50	–	–
West Clarendon										
Portland Bight	–	–	–	–	8	22.50	8	31.25	–	–
Drunken Man's	–	–	–	–	6	53.24	3	17.50	4	20.63
Cay										
Kingston										
Port Royal	–	–	–	–	7	35.63	10	45.63	7	34.38
Average										16.67

Table AV.
The impact on Jamaica's coral reefs: depth and hard coral cover, by year

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