



Policies, Strategies and Best Practices for Managing Invasive Alien Species (IAS) in the Insular Caribbean

March 31st – April 4th 2014

Radisson Trinidad . Port of Spain, Trinidad & Tobago



Photo courtesy: Kirsty Swinnerton

PROGRAMME & ABSTRACTS

IAS

*“they settle on an inch
and invade for miles...”*

The MTIASIC Project:

“Mitigating the Threats of Invasive Alien Species in the Insular Caribbean”

Invasive Alien Species (IAS) are a major threat to the vulnerable marine, freshwater and terrestrial biodiversity of Caribbean countries, especially the many island states. IAS are also a major threat to the people depending on this biodiversity for their livelihoods and wellbeing. Due to the nature of many of the invasive species and their ability to spread and colonise new areas, any attempt to tackle this threat requires a regional effort. Caribbean states have recognised this need for a regional strategy, in line with the Convention on Biological Diversity’s declaration that efforts must be made to prevent, control or eradicate invasive species that threaten ecosystems.

The United Nations Environment Programme (UNEP) as the Implementing Agency partnered with CAB International (CABI) as the Regional Executing Agency and five national executing agencies: The Department of Marine Resources in the Bahamas; the Ministry of the Environment and Natural Resources in the Dominican Republic; the National Environment and Planning Agency (NEPA) in Jamaica; the Forestry Department, Ministry of Sustainable Development, Energy, Science and Technology in Saint Lucia; and the Ministry of Food Production in Trinidad and Tobago. Additionally, there were over 22 regional and international partners and numerous partners in each of the five participating countries.

The project started in September 2009. The project goal is to conserve globally important ecosystems, the species and genetic diversity within the insular Caribbean. The objective is to mitigate the threat to local biodiversity and economy from IAS in the insular Caribbean, including terrestrial, freshwater, and marine ecosystems. The project undertook a wide range of activities in five major components as follows:

- Development of National IAS Strategies
- Development of a Caribbean-wide Strategy and cooperation mechanism
- Knowledge Generation, Management and dissemination
- Increase Capacity to Strengthen Prevention of new IAS Introductions in Terrestrial, Freshwater and Marine Systems.
- Increase Capacity to Detect, Respond, Control and Manage IAS Impacts in Terrestrial, Freshwater and Marine Systems.

In parallel to one and two above participating countries executed 12 pilot projects. These projects ranged from prevention, early detection and rapid response to management and eradication. Over the period 31 March to April 4 we will highlight the achievements of this project. It will also be an opportunity to hear from no project scientist and partners from the wider Caribbean. It also serve to strengthen opportunities for collaboration and ensure sustainability of efforts in dealing with this threat in the future.

The following table highlights the 12 pilot projects relating to prevention, early detection and rapid response, management, and eradication of the some invasive species.

Twelve (12) National Pilot Projects

Mitigating the Threats of Invasive Alien Species in the Insular Caribbean (MTIASIC)

A project by UNEP-GEF and CAB International

Bahamas	<ol style="list-style-type: none"> 1. A Local and regional research, training and Management Approach to the Lionfish. That involves revising the National IAS strategy, conducting research on the impact of Lionfish. Actively conducting research to determine best control and management strategies in various habitat types.
Dominican Republic	<ol style="list-style-type: none"> 2. Eradication of alien vertebrate predators and one alien invasive Plant Species from Alto Velo island (Species targeted: <i>Rattus norvegicus</i>/<i>Rattus rattus</i> (brown and black rat) <i>Felis catus d.</i> (cat); <i>Azadirachta indica</i> (neem). 3. Eradication of an alien vertebrate predators and herbivores from Isla Cabritos in Lago Enriquillo (species targeted: <i>Felis catus d.</i> (cat); <i>Capra hircus</i> (goat); <i>Equus asinus</i> (donkey).
Jamaica	<ol style="list-style-type: none"> 4. Management and control of the marine invasive species, <i>Pterois volitans</i> (Lionfish) to prevent the impending population explosion in the Caribbean Sea. 5. Monitoring and selective eradication of vertebrate predators in the last remaining habitat of the Jamaican Iguana (<i>Cyclura collie</i>) in the Portland Bight Protected Area. (Species targeted: <i>Canis familiaris</i> (Dog); <i>Capra hircus</i> (Goat) <i>Felis catus</i> (cat); <i>Herpestes javanicus</i> (Mongoose); <i>Sus scrofa</i> (Feral Pigs). 6. Control and management of two invasive freshwater animals and plants in the Lower Black River Morass (Ramsar Site) to prevent further habitat loss. (Species targeted: <i>Cherax quadricarivatus</i> (Australian Red Crayfish) <i>Pterygoplichthys paradalis</i> (Sucker mouth catfish) <i>Alpina allughas</i> (Ginger) and <i>Melaleuca quinquenervia</i> (Paper Bark Tree/ Melaleuca).
Saint Lucia	<ol style="list-style-type: none"> 7. Protection of Saint Lucia's unique biodiversity through eradication of invasive alien Iguanas. 8. To protect the Maria Island Nature Reserve for the threat of Invasive Alien Species (IAS)
Trinidad and Tobago	<ol style="list-style-type: none"> 9. The maintenance of the native biodiversity of the ecologically sensitive area – Nariva Swamp by the control and management of <i>Raoiella indica</i> (Red Palm Mite) and <i>Batrachedra nuciferae</i> (Coconut Moth) 10. Preventing the entry of <i>Moniliophthora rorei</i> (causal agent of frosty pod rot of Cocoa) into Trinidad and Tobago. 11. Management and Control of the marine invasive <i>Perna viridis</i> (green mussel) in Trinidad and Tobago. 12. Mitigating the impact of Aquatic IAS in Trinidad and Tobago through the increased awareness of key stakeholders.

Policies, Strategies and Best Practices for Managing Invasive Alien Species (IAS) in the Insular Caribbean

March 31st – April 4th 2014
Radisson Trinidad
Port of Spain, Trinidad & Tobago

Objectives of the Conference:

- To highlight the economic impact of IAS in the Caribbean.
- To share best practices, strategies; effective communication tools and techniques for managing and controlling IAS in the Caribbean.
- To foster greater regional collaboration for dealing with IAS in the region.
- Highlight the actions and achievements of the Project: “Mitigating the Threats of Invasive Alien Species in the Insular Caribbean” (MTIASIC).
- Create greater awareness of IAS issues in the wider Caribbean.

Day One. Monday March 31, 2014

Session One: Counting the Impacts of IAS in the Caribbean.

TIME	TITLE AND AUTHOR	COUNTRY
8.00-8.30	Registration	
8.30-8.35	Security Briefing	Hotel
8.35-8.40	Welcome and introduction of Session Chair	CABI
8.40-9.10	1. Invasive Species Management in the Pacific using Survey Data and Cost-Benefit Analysis with applications for the Caribbean” Adam Daigneault and Pike Brown.	New Zealand
9.10-9.25	2. CBA of Casuarina Species Management on Eleuthera Island, The Bahamas-Governor’s Harbour Airport: A Case Study” Ingeria Miller, Christopher Russell and Mark Daniels	Bahamas
9.25-9.40	3. Benefits to Biodiversity outweigh cost of Vertebrate Eradication on Cabritos Island. Carlos Rijo	Dominican Republic
9.40-9.55	4. An Assessment of the Potential Impacts of an Invasive Alien Species: the Case of Lionfish (<i>Pterois volitans</i> and <i>Pterois miles</i>) on the Fishery Sector in Jamaica. Stephan Moonsammy, Govind Seepersad and Dayne Buddo	Trinidad/ Jamaica
9.55-10.10	5. Economic Analysis of Lionfish Management in Jamaica. Denise Chin, Sean Townsend, and Loureene Jones Smith	Jamaica
10.10-10.30	Discussion	
10.30-10.45	Coffee	
10.45-11.00	6. Economic Analysis of the Removal of Feral Goats on Goat Islands, South Coast, Jamaica. Townsend, S.E., Jones Smith, L. and Chin, D.	Jamaica
11.00-11.15	7. An Assessment of the Economic Impacts of an Invasive Alien Species- the cases of the Varroa mite and Africanized Honey Bee in Trinidad and Tobago. Govind Seepersad, Ardon Iton and Stephan Moonsammy	Trinidad and Tobago
11.15-11.30	8. An Economic Analysis of the Management of the Invasive Weed, Whitetop on the UTT Waterloo Research Campus. Kimberly Singh	Trinidad and Tobago
11.30-11.45	9. An Economic Analysis of Three Management Options of the Giant African Snail (<i>Achatina fulica</i>) in Trinidad and Tobago. Allan Balfour and Nazia Ali.	Trinidad and Tobago
11.45-12.00	10. An Economic Assessment of the Impact of <i>Raoiella indica</i> on the Nariva Swamp, Trinidad and Tobago. Marc Garcia	Trinidad and Tobago
12.00-12.30	Discussion	
12.30-1.30	Lunch	
1.30-3.30	Workshop: Develop a brief for policy makers that highlight social, economic and environmental impacts of IAS in the Caribbean. Using only Caribbean examples produced during the CBA projects undertaken by the MTIASIC project and other data presented during the session and available in the literature.	Adam Daigneault and Pike Brown
3.30-4.40	Plenary Session: presentation of group discussion and compilation of main points for to be presented on Tuesday morning at the opening Ceremony.	

Day Two. Tuesday April 1, 2014

Opening Ceremony: 8.30-10.00

Programme to be circulated separately.

Session Two: Reducing the Risks of New Introductions

TIME	TITLE AND AUTHOR	COUNTRY
10.00-10.15	11. Risk Factors Associated with Various Pathways for Invasive Species or Pest and Disease Introductions into the Caribbean. Wayne DeChi	Trinidad and Tobago
10.15-10.30	12. Assessing the secondary spread of invasive species in the Caribbean via shipping: an example with <i>Perna viridis</i> Jonathan Bossenbroek. Jonathan Bossenbroek and Stephan Moonsammy	USA/ Trinidad and Tobago
10.30-10.45	13. The Cane Toad Invasion: Its Origin, Status and The Bahamas' Response to prevent spread. Janeen Bullard, Sandra Buckner, Scott Johnson	Bahamas
10.45-11.00	14. Maintaining Offshore Islands IAS Free is a Viable Strategy for Protecting Endangered Endemic species. Krauss, U.; Isidore, L.; Jn Baptiste, T.; Lesmond, S.; James, M.; Hunt, S.; Petersen, L.; Dornelly, A.; Joseph, A.; Williams Peter, S.; Morton, M.; John, L.; Bobb, M.	Saint Luica
11.00-11.15	15. Restoring biodiversity to Isla Alto Velo and Isla Catalina, Dominican Republic, through invasive vertebrate removal: an assessment of challenges and opportunities. Kirsty Swinnerton, Jose Luis Herrera, Yolanda León, Carlos Rijo, Francisco Núñez, Nelson García	Bahamas/ Dominican Republic
11.15-12.00	16. Preventing the Introduction of an Invasive Alien Species, Frosty Pod Rot (causal organism, <i>Moniliophthora rorei</i> (Ciferi & Parodi) Evans et al.): the Trinidad and Tobago Experience. Deanne V. Ramroop.	Trinidad and Tobago
12.00-12.30	Discussion	
12.30-1.30	Lunch	
1.30-1.45	17. Use of Native Dominican Drone (<i>Xylocopa mordax</i>) as Pollinator in Greenhouse Tomato Crop: a local alternative versus the introduction of bumblebees of the Genus <i>Bombus</i> . Kelvin Guerrero, Dimas Liranzo, José A. Canela, Mary Tavera	Dominican Republic
1.45-2.00	18. Developing a National IAS Strategy focussed on IAS prevention – a case study of the Bahamas' 2003 -2013 experience. Janeen Bullard.	Bahamas
2.00-2.15	19. www.ciasnet.org Forewarned is forearmed in the battle against Invasives. Naitram Ramnanan and Avenesh Ali	Trinidad and Tobago
2.15 -4.15	Workshop: Refine Practical Implementable Recommendations that reduce risks associated with major pathways of IAS introductions in the Caribbean.	USDA/Aphis
4.15-5.30	Plenary Presentation and Wrap up discussion	

Day Three. Wednesday April 2, 2014

Session Three: Appropriate Practices for Eradication, Managing and Control of IAS in the Caribbean.

TIME	TITLE OF PRESENTATION/AUTHOR	COUNTRY
8.00-8.15	20. MTIASIC Bahamas Lionfish Control Project: Findings and Management Implications. Nicola Smith and Krista Sherman	Bahamas
8.15-8.30	21. Saving Caribbean Endangered Species by Removing Invasive Vertebrates – experiences from the Isla Cabritos Pilot Project. Authors: Kirsty Swinnerton, Jose Luis Herrera, Carlos Rijo, Robert Ortiz, and Jorge Brocca	Bahamas/ Dominican Republic
8.30-8.45	22. The Jamaican Iguana – from Rediscovery to Recovery. Byron Wilson and Kimberly Stephenson	Jamaica
8.45-9.00	23. An assessment of control methods for Invasive Alien Iguanas in Saint Lucia. Krauss, U.; Isidore, L.; Mitchel, N.; Seely, L.; Alfred, P.; Ramessar, A.; Johnny, A.; Joseph, B.; James, M.; Dornelly, A.; Breuil, M.; Vuillaume, B.; Morton, M.; John, L.; Bobb, M.	Saint Lucia.
9.00-9.15	24. Public Health Concerns for Capture and Consumption of Lionfish in Jamaica. Dayne Buddoo,	Jamaica
9.15-9.30	25. Building a Sustainable National Marine Protected Area Network: Controlling lionfish populations in Marine Protected Areas. Krista Sherman, Craig Dahlgren, Stacey Moultrie, Frederick Arnett	Bahamas
9.30-10.00	Discussion	
10.00-10.15	Coffee	
10.15-10.30	26. The anatomy of the <i>Perna viridis</i> invasion in Trinidad and Tobago. Rosemarie Kishore and Chevelia Chase	Trinidad and Tobago
10.30-10.45	27. Tobago's Freshwater AIS; they came, they stayed and now they spread! Ryan S. Mohammed	Trinidad and Tobago
10.45-11.00	28. Assessing the Effectiveness of Different Herbicides in the Control of Melaleuca Trees and Saplings. Kurt McLaren and Kurt Prospere.	Jamaica
11.00-11.15	29. The Effects of Patch Size and Invasive Plants on the Diversity and Structure of a Tropical Swamp Forest. Kurt Prospere, Kurt McLaren and Byron Wilson.	Jamaica
11.15 -11.30	30. Red Palm Mite, <i>Raoiella indica</i> Hirst (<i>Acari: Tenuipalpidae</i>): A Threat to Moriche Palm (<i>Mauritia flexuosa</i>) in the Nariva Swamp of Trinidad and the pursuit of Integrated Pest Management strategies. Farzan Hosein, Seepersad Ramnarine, Christine Omadath, Khaliqa Mohammed, Tavia Bandoo, Safraz Ali, Roopnarine Singh.	Trinidad and Tobago
11.30-11.45	31. Acacia mangium, an invasive species with potential for rehabilitation of abandoned quarries. Seepersad Ramnarine	Trinidad and Tobago
11.45-12.00	32. Is Teak (<i>Tectona grandis</i> L) an invasive species in Trinidad and Tobago? Seepersad Ramnarine	Trinidad and Tobago
12.00-12.30	Discussion	Trinidad and Tobago
12.30-1.30	Lunch	

TIME	TITLE OF PRESENTATION/AUTHOR	COUNTRY
1.30-3.30	Simultaneous Workshop Sessions: Experience the best teacher ... distil from the MTIASIC and other experiences some recommendations that can be regarded as appropriate / best practices in managing IAS in the Caribbean. These will be done in three separate working groups:	
	Group One: Managing Invasive Plants and Plant Pathogens	Arne Witt
	Group Two: Managing Invasive Vertebrates:	Kristy Swinnerton
	Group Three: Managing Invasive Fresh Water and Marine Species Chair	Jonathan Bossenbroek
3.30-4.30	Plenary session – presentations by each working group and wrap up discussions	

Day Four. Thursday April 3, 2014

Field Trip: Visit to Nariva Swamp 10.00 am - 4.00 pm **Exhibition:** 10.00 am (Opening) – 6.00 pm

Day Five. Friday April 4, 2014

Exhibition: 10.00 am – 6.00 pm

Session Five: Effectively communicating to the Caribbean public to achieve fewer IAS introduction and lower spread

TIME	TITLE AND AUTHOR	COUNTRY
8.30-8.45	33. Speaking IAS - Effectively Communicating the Message. Nelsa English-Johnson and Caryl Grant	Jamaica
8.45-9.00	34. Travellers Don't Pack a Pest Outreach Program. Wayne DeChi,	Trinidad and Tobago
9.00-9.15	35. Protecting Black River's Biodiversity-Preserving Our Legacy the Black River Area Social Marketing Campaign. Nelsa English-Johnson and Caryl Grant.	Jamaica
9.15-9.30	36. Communication Strategies for Alien Invasive Species. Wilhelmina Kissoosingh and Deokie Bholasingh-Hay.	Trinidad and Tobago
9.30-9.45	37. "Edutaining" the Caribbean on IAS – an effective tool in the communication box. Chike Farrell, Cordell Lawrence, James Amow, Belinda Caruth and Naitram Ramnanan	Trinidad and Tobago
9.45-10.15	Discussion	
10.15-10.30	Coffee	
	Six: Building and sustaining an effective IAS network across the Wider Caribbean: Chair CABI.	
10.30-10.45	38. A Network of Crop Protection Specialist and Policy Markers for the protection of Caribbean plant resources: The Caribbean Plant Health Directors (CPHD) Forum. Wayne De Chi	Trinidad and Tobago

TIME	TITLE AND AUTHOR	COUNTRY
10.45-11.00	39. Networking Stakeholders from Key Biodiversity Areas into a Virtual Caribbean Network for Invasive Alien Species. Rafique Bailey and Naitram Ramnanan	Saint Vincent and Trinidad and Tobago
11.00-11.15	40. Sustainable Forestry Partnerships. Ingeria Miller	Bahamas
11.15-11.30	41. All Hands on Deck: Partnerships at work against an Invader Dayne Buddoo	Jamaica
11.30-11.45	42. The Leon Levy Native Plant Preserve: Its History, Development and Strategies for Managing Invasive Flora. Mark Daniels	Bahamas
11.45-12.15	Discussion Workshop task: Outline a strategy to get sustained private sector participation in a Caribbean IAS Network	
12.15-1.15	Lunch	
1.15-3.15	Simultaneous Working groups for Sessions Five and Six	
3.15-4.30	Plenary session and wrap up	

ABSTRACTS

Day One. Monday 31 March 2014.

SESSION ONE: COUNTING THE IMPACTS OF IAS IN THE CARIBBEAN

1. INVASIVE SPECIES MANAGEMENT IN THE PACIFIC USING SURVEY DATA AND COST-BENEFIT ANALYSIS WITH APPLICATIONS FOR THE CARIBBEAN

Adam Daigneault and **Pike Brown Landcare**, New Zealand.

Invasive alien species pose an enormous threat in the Pacific: not only do they strongly affect biodiversity, but they also potentially affect the economic, social, and cultural wellbeing of Pacific peoples. Invasive alien species can be managed and their impacts can be avoided, eliminated, or reduced. However, neither the costs nor the numerous benefits of management for most species have been concretely articulated in the Pacific. Thus, we undertook cost-benefit analyses (CBAs) of managing five species that are well established on Viti Levu, Fiji: *spathodea campanulata* (African tulip tree), *herpestus auropunctatus* (small Asian mongoose), *papuana uninodis* (taro beetle), *pycnonotus cafer* (red-vented bulbul), and *merremia peltata* (merremia vine). These CBAs are informed by extensive survey data that record the incidence, management, and impacts of each species in Fiji. We find that the most cost-effective management option varies by species, precluding a universal solution. Nevertheless, the benefits of management often exceed the costs of management by a wide margin, arguing for a more concerted effort to control the spread of invasive alien species in the Pacific. We also discuss how similar methods to assess the costs and benefits of managing invasive alien species could be applied in the Caribbean given geographic, climatic, and economic similarities to the Pacific.

Keywords: Invasive Alien Species, cost-benefit analysis, small island developing states, non-market valuation

2. COST BENEFIT ANALYSIS OF CASUARINA SPECIES MANAGEMENT ON ELEUTHERA ISLAND, THE BAHAMAS - GOVERNOR'S HARBOUR AIRPORT: A CASE STUDY

Ingeria Miller, Christopher Russell, and Mark Daniels. Ministry of the Environment and Housing, Forestry Unit. N-356, Nassau, The Bahamas.

The purpose of this study is to conduct a benefit cost analysis that estimates economically efficient options to manage the Casuarina species at the settlement level in Governor's Harbour, Eleuthera, The Bahamas. The study site is situated at the Governor's Harbor Airport (~104 acres). A one hectare plot within the study area was used for the case study and the results extrapolated over the hundred and four (104) acres. Introduced in the 1950s, Casuarina (Australian pine) (*Casuarina* sp.) species occurs throughout the islands of The Bahamas. The species is considered to be extremely problematic to eradicate, as it is taking over natural systems and out-competing native species creating monotypic stands. Without some form of management intervention, the invasion is expected to continue unabated to the extent that entire beaches along the coastline of affected islands will become eroded and the natural indigenous vegetation will be totally replaced with the Casuarina species. This case study investigated four management options for Casuarina. The first option was to do nothing. The second management option was a Public/Private Partnership programme of control (removal and replacement with native species followed by annual monitoring). Thirdly, a Government – led Public Education Programme.– involving the use of television, radio, social media, town meetings and newspapers to educate and build awareness of the problem),. Fourthly, an Integrated Approach that combines options 2 and 3. A sensitivity analysis was also conducted to assess the validity of the results. Additionally, to investigate the socio-economic impacts of invasive species in Governor's Harbour, two questionnaires were designed. One questionnaire targeted residents of Governors Harbour Eleuthera and the other focused on a small cross section of informed stakeholders on the island. Eighty residents were surveyed out of the total population of the settlement during execution of the first questionnaire. Information on the biophysical growth and effectiveness of various management options to control the invasive were primarily obtained from scientific literature. The case study concluded that Eleutherans were most willing

to support the integrated approach of managing Casuarina. Additionally, residents were deeply divided on whether or not Casuarina could be controlled and whether it could affect a country's economy. With respect to the economics of controlling Casuarina, the majority of the benefits would accrue from avoided damages to utility and road infrastructure, erosion reduction/beach renourishment costs, increased biodiversity/improved habitat, and profit gained from sale of products. The Cost Benefit Analysis revealed that the Public/Private Partnership Approach (Search & Destroy) yielded the highest net present value and ranked number one out of all the management options investigated in the study. Second and third ranking fell to the Government led Public Education Campaign and Integrated management Approach options respectively. The highest benefit to cost ratio was achieved with the Public/Private Partnership, with the second and third rankings belonging to the Integrated Approach and the Government-led Public Education Campaign. The most cost effective option was the Public/Private Partnership followed by the Government-led Public Education Campaign, with the Integrated Approach placing third.

Keywords: Bahamas, Invasive Alien Species, Casuarina, cost-benefit analysis, non-market valuation

3. BENEFITS TO BIODIVERSITY OUTWEIGH COST OF VERTEBRATE ERADICATION ON CABRITOS ISLAND

Carlos Rijo. Ministry of Environment and Natural Resources, Dominican Republic

The presence of invasive mammals in Cabritos for a long time have degraded the fragile ecosystem where native Dominican Republic iguanas, the Ricord iguana (*Cyclura ricordi*) and the Rhinoceros iguana (*Cyclura cornutha*) are living; both species are threatened by the donkeys and cats settled on the island. After a baseline study in 2011, the donkeys population was assessed at 127 individuals and activities to eradicate and remove those individual were conducted using snares, catching alive the animals, transporting, and giving to the main land farmers for use as draught animal. After one year of effort of capture, a total of 100 animal were captured. The snare trapping methodology was changed, after the population was significantly decreased and was necessary to incorporate ground hunters to continue removing the invasive mammals that are impacting the island's biodiversity. These activities were implemented under the project "Mitigating the Threats of Invasive Alien Species in the Insular Caribbean", funding by UNEP/GEF and implemented by CABI at the Regional Level. In the Dominican Republic it was implemented by the Ministry of Environment and Natural Resources. Cabritos was one of the pilot projects and after two years, removing donkeys and one year removing cats, the recruitment of Ricord iguana and the presence of natural grass are giving a new aspect to the island. In this presentation a cost- benefits analysis is made comparing the different options for donkey eradication, using CBA to evaluate the eradication. Results show that the eradication in the long terms will give benefits to both the biodiversity and the ecotourism on the Island.

Keywords: Cabritos Island, Dominican Republic, Invasive Alien Species, *Cyclura ricordi*, *Cyclura cornutha*, cats, donkeys, cost-benefit analysis

4. AN ASSESSMENT OF THE POTENTIAL IMPACTS OF AN INVASIVE ALIEN SPECIES: THE CASE OF LIONFISH (*Pterois volitans* and *Pterois miles*) ON THE FISHERY SECTOR IN JAMAICA

Stephan Moonsammy¹, Govind Seepersad¹ and Dayne Buddo² ¹Department of Agriculture Economics and Extension, Faculty of Food and Agriculture, University of the West Indies, St. Augustine. ²Marine Invasive Species Lab, Discovery Bay Field Station, University of the West Indies, Mona Campus.

Recent research has shown that the problem with invasive alien species (IAS) is predominantly an economic one. The Lionfish was first observed in Jamaica in 2006 and has now established a population in the reef habitats of the country. There are several direct and indirect biological and socioeconomic impacts associated with the Lionfish invasion in Jamaica. In order to determine the potential costs of the Lionfish impacts in Jamaica, a study was conducted in the country in 2011. Data sourced from primary and secondary sources was compiled and analyzed using a combination of logistic regression analysis, simulation and forecasting. The study also conducted a benefit-cost ratio to determine whether a potential control and management programme for the Lionfish invasion in Jamaica was feasible. The results showed that the Lionfish can potentially cost the fisheries sector of Jamaica an estimated sum of USD 46.2 million. The results also showed that a control and management programme for the Lionfish in Jamaica is feasible. The information generated from the study reveals that the Lionfish is costing Jamaica more than 50% of the total contribution that the entire fisheries sector contribute to national gross domestic production. It was recommended that the population growth and dispersion of the Lionfish be controlled by implementing a concise control and management programme.

Keywords: Direct impacts, indirect impacts, fisheries, Jamaica, Lionfish. *Pterois volitans* and *Pterois miles*

5. ECONOMIC ANALYSIS OF LIONFISH MANAGEMENT IN JAMAICA

Denise Chin¹, Sean Townsend² and Loureene Jones Smith³. ¹Department of Life Sciences, Faculty of Science and Technology, University of the West Indies, Mona Campus, Kingston 7, Jamaica, W.I. ²Natural Resources Management & Environmental Planning Department, Planning, Development and Project Management Division, Urban Development Cooperation ³Ecosystems Management Branch, Environmental Management & Conservation Division, National Environment and Planning Agency.

Lionfish is one of the more recent marine invasive alien species (IAS) found in the Caribbean with the potential to significantly impact an already overfished fishing industry. They consume a wide variety of fin and shellfish including commercially important fish such as snappers and groupers. Crab, shrimp, parrotfish and squirrelfish are also among the wide variety of organisms that they prey on. It is believed that there are two species of Lionfish found in the Caribbean waters namely: *Pterois volitans* and *Pterois miles*. They originate from the Indo Pacific Ocean where they are mainly nocturnal predators; in the Caribbean this behaviour has changed as they hunt throughout the day because of the lack of predators. These species are thought to have been introduced by the aquarium trade by aquaria enthusiasts. They, like many invasives, reproduce at an alarming rate and have the potential to reproduce every four days all year round. A single female is able to produce about two million eggs annually. The potential impacts as well as the observed spread of the organism throughout the Caribbean, led to the execution of a cost benefit analysis to explore several management options to control their spread and impact. The management options explored were an active capture and removal programme via spear fishing; a passive approach using fish pots; combined management programme (active and passive) as well as a “do nothing” management option. All options included public education executed at various scales over a 15 year period using economic indices for 2013-2014.

Keywords: Lionfish, Invasive Species, Jamaica, cost benefit analysis

6. ECONOMIC ANALYSIS OF THE REMOVAL OF FERAL GOATS ON GOAT ISLANDS, SOUTH COAST, JAMAICA

Townsend, S.E.¹, Jones Smith, L.² and Chin, D.³. ¹Urban Development Corporation, ²National Environment and Planning Agency, ³University of the West Indies.

The Jamaican Iguana (*Cyclura collei*) is Jamaica's largest endemic reptile and one of the rarest animals in the world; it is listed as critically endangered on the IUCN Red List of Threatened Species. Prior to the mid-1800s the animal was widespread throughout the country but it is now only found on the south coast in the dry limestone forests of the Hellshire Hills. The distribution and population is negatively impacted by the introduction of the Small Indian Mongoose as well as feral populations of pigs, cats, dogs and goats (*Capra sp.*). They are also threatened with habitat loss. The animal was thought to be extinct but was rediscovered in the 1970s; a small population was also reconfirmed in the 1990s. For approximately 20 years various strategies have been employed to increase the number of iguanas. This has been via a "headstart" programme which included an extensive trapping programme to remove predators. One additional strategy to be employed is the establishment of a satellite population on the nearby Goat Islands; currently home to a small feral goat population. This cost benefit analysis investigates the economic effectiveness of four management options namely: 1) eradication of the feral goat population using trained hunters and dogs; 2) a public awareness campaign; 3) a combined eradication and public awareness programme; and 4) a "do nothing" management option. These were compared for a 20 year management period to determine which option would be the most cost effective using the limited resources available to the Government and the Jamaican Iguana Recovery Group.

Keywords: Jamaican Iguana, feral goats, invasive alien species, goat eradication, Goat Islands, *Cyclura collei*, *Capra sp.*, cost benefit analysis, economic impact assessment, IAS eradication

7. AN ASSESSMENT OF THE ECONOMIC IMPACTS OF AN INVASIVE ALIEN SPECIES- THE CASES OF THE VARROA MITE AND AFRICANIZED HONEY BEE IN TRINIDAD AND TOBAGO

Govind Seepersad, Ardon Iton and Stephan Moonsammy. Department of Agriculture Economics and Extension, Faculty of Food and Agriculture, University of the West Indies, St. Augustine, Trinidad and Tobago.

Invasive Alien Species (IAS) has the potential to generate significant damage to an economy. Studies have shown that IAS have affected the output from most economic sectors especially food production. In Trinidad and Tobago, several invasive species continue to affect the agricultural sector. This study proposes to assess the impacts caused by two specific invasive species to the honey industry in Trinidad and Tobago. The main objective of this study is to determine the various economic costs accrued by bee keepers as a result of the presence of Varroa mite and the Africanized Honey Bee. The study also attempts to determine the bee keepers' perception and management strategies when coping with the Varroa mite and Africanized Honey Bee. The data used to assess the economic impacts of the Varroa mite and Africanized Honey Bees was collected using a questionnaire specifically designed for bee keepers. A sample of 80 bee keepers was surveyed across Trinidad and Tobago. The data was analyzed using linear regression analysis and analysis of variance. Preliminary results showed that bee keepers were incurring costs in order to adopt various management strategies to cope with IAS. Further analysis will be required in order to determine the full extent of the economic impacts caused by the two invasive species.

Keywords: Africanized Honey Bees, bee keepers, economic impacts, Varroa mite

8. AN ECONOMIC ANALYSIS OF THE MANAGEMENT OF THE INVASIVE WEED, WHITETOP, ON THE UTT WATERLOO RESEARCH CAMPUS

Kimberly Singh, Research Assistant. The University of Trinidad and Tobago, Centre for Biosciences, Agriculture and Food Technology, Waterloo Research Campus, Waterloo Estates, Carapichaima, Trinidad.

Whitetop (*Parthenium hysterophorus*) is a noxious and invasive weed that reduces crop yield and quality and has shown to be harmful to humans and animals. The weed is characterized by its vigorous growth, high fecundity and allelopathic properties. This study reviews several management options that set out to prevent and/or control the spread of this invasive weed species in order to mitigate its adverse effects. A cost-benefit analysis of the four management options was conducted at Waterloo Research Campus of The University of Trinidad and Tobago over a one-year period beginning March 2013. We evaluated several variables including benefit and cost values of agricultural crops, human health, labour, herbicides and research amongst others, using the logistic curve toolkit developed by Landcare Research, New Zealand. The ranking function within the toolkit suggested that an 'Integrated Management Approach' attributed the highest Net Present Value whereas the 'Current Management' option ranked highest as the option with the greatest Benefit-Cost Ratio, displaying the most benefits expected for each dollar of costs. The 'Current Management' option also ranked first in terms of cost-effectiveness. The success of this preliminary model will now be extended to several industrial and agricultural locations in Trinidad where the weed is persistent and difficult to manage.

Keywords: Whitetop, *Parthenium hysterophorus*, invasive weed, cost-benefit analysis, Trinidad and Tobago

9. AN ECONOMIC ANALYSIS OF THREE MANAGEMENT OPTIONS OF THE GIANT AFRICAN SNAIL (*Achatina Fulica*) IN TRINIDAD AND TOBAGO

Allan Balfour and **Nazia Ali**, Ministry of Food Production, Trinidad and Tobago.

In October 2008, the giant African snail (*Achatina fulica*) was introduced to Trinidad. The highly invasive pest had a potential to cause serious damage in the agricultural, health and environmental sectors and also threatened international trade. The pest was confined to the Diego Martin Valley, north western Trinidad. These factors initiated a highly intensive eradication programme led by the Research Division in association other divisions and external agencies. The programme was multifaceted and comprised of weekly baiting and monitoring operations, a public awareness programme, field sanitation, surveillance and the development of legislation. By the end of 2012 a total number of 34,747 snails were collected and an average annual cost of \$ 1,520,000.00 incurred. After successful containment of the giant African snail (GAS) for 5 years within the Diego Martin Valley (the Eradication Zone), the pest was discovered in two towns east of the containment. Hence the management programme was considered to address the new dynamics of the pest outbreak. The cost benefit analysis conducted included collation of data from several agricultural agencies and a survey of residents. Most preliminary results reflected that the public was in favour of some control over the GAS and that it was damaging to aspects of the local environment. The data for the cost benefit analysis of the Management Option was 40% less than that of the Eradication Option. The recommendations generated from this project served to inform on cost effective approaches against the giant African snail outbreak.

Key words: *Achatina fulica*, invasive species, Trinidad, surveillance, control methods

10. AN ECONOMIC ASSESSMENT OF THE IMPACT OF *Raoiella indica* ON THE NARIVA SWAMP, TRINIDAD AND TOBAGO

Marc Garcia, The University of the West Indies, St. Augustine, Trinidad and Tobago.

The Red Palm Mite (*Raoiella Indica*) is a great threat to terrestrial biodiversity, with particular interest in palm populations. In Trinidad and Tobago, the Coconut palm (*Cocos nucifera*) has been the most affected. The local Nariva Swamp, a designated Ramsar site, hosts large populations of various palm species. The impact of the Red Palm Mite on this ecosystem can be both direct and indirect. Its direct impacts include declining yields of coconuts and increased market prices. Indirect impacts of this invasion include the loss of non-market ecosystem goods and services such as the change to aesthetic values and demand for recreational services. The study was aimed at calculating the indirect costs of invasion, creating an awareness campaign and stating a case for the use of web-based surveys in local contingent studies. Contingent Valuation was used to estimate the non-market impacts. Data was collected for this study using both web-based surveys and interviewer administered questionnaires at the study site. The data was analyzed using mainly Logistic Regression, yielding a mean willingness to pay for the mite's removal of USD \$37. Respondents' view of the swamp and attitudes to environmental degradation significantly affected willingness-to-pay for conservation. No significant differences were found between survey modes.

Keywords: Red Palm Mite, Nariva Swamp, contingent valuation, logistic regression, web-based surveys, awareness campaign, Trinidad and Tobago, Caribbean

Day Two. Tuesday 1 April 2014

SESSION TWO: REDUCING THE RISKS OF NEW INTRODUCTIONS

11. RISK FACTORS ASSOCIATED WITH VARIOUS PATHWAYS FOR INVASIVE SPECIES OR PEST AND DISEASE INTRODUCTIONS INTO THE CARIBBEAN.

Wayne DeChi, Agricultural Officer, USDA/APHIS.

Invasive species has long been identified as a factor in the deteriorating food security of the Caribbean. It is globally accepted as a leading driver of biodiversity loss and environmental change. Since 1995, poverty levels have increased, while traditional exports have declined, and food imports have increased. Invasive species partially account for high cost of production, lower yields that result in higher levels of importation. This paper reviews the “*Evaluation of Pathway for Exotic Plant Pest Movement into and within the Greater Caribbean Region*” by Dr. Heike Meissner, USDA, with the accompanying recommendations in the context of devising best practices for managing risks associated with IAS introductions into the Caribbean. The objective is to contribute to an improved understanding of pathways of plant pest movement into and within the Greater Caribbean Region. The major pathways of concern to biodiversity are human movement, international mail, forestry, natural spread, airline passenger baggage, maritime traffic, wood packing material, propagative material, and international garbage. The major recommendations of focus are i) regional coordination, planning and communication ii) education and involvement of the public iii) early warning, bio- surveillance and pest information systems and iv) preparedness and rapid response.

Key Words: Invasive species, pests, diseases, risk factors, pathways

12. ASSESSING THE SECONDARY SPREAD OF INVASIVE SPECIES IN THE CARIBBEAN VIA SHIPPING: AN EXAMPLE WITH *Perna viridis*

Jonathan Bossenbroek¹ and **Stephan Moonsammy**² ¹Department of Environmental Sciences, University of Toledo, Toledo, OH & Fulbright Scholar, University of West Indies, St. Augustine, Trinidad and Tobago. ²Department of Agriculture Economics and Extension, Faculty of Food and Agriculture, University of the West Indies, St. Augustine, Trinidad and Tobago.

Shipping is a major vector of the spread of invasive species throughout the globe. Shipping was the likely vector of *Perna viridis*, which arrived in Trinidad in 1990. This introduction resulted in substantial economic damages and ecological impacts. Since this introduction, secondary spread of *P. viridis* via shipping and currents within the Caribbean has resulted in populations in Venezuela, Cuba, Jamaica and Florida. Predicting future impacts of *P. viridis* and other marine invasive species requires models of potential spread, an understanding of potential habitat, and an assessment of potential damages. We have built a shipping model of the Caribbean region to predict what locations are likely to have new introductions of *P. viridis*. We have also begun to assess the likely impacts of *P. viridis* to locations we predict as likely locations of new introductions. The industries most likely to be impacted by *P. viridis* include power plants and desalination plants that use water taken directly from the sea. These plants thus have the possibility of increased maintenance and reduced efficiencies if new biofouling organisms are introduced. Our efforts to understand the past and future spread of *P. viridis* will establish a framework to assess how potential ballast water management strategies will influence the future spread of marine invasive species throughout the Caribbean.

Keywords: Invasive species, *Perna viridis*, Trinidad and Tobago, shipping, pathway, impact models

13. THE CANE TOAD INVASION: ITS ORIGIN, STATUS AND THE BAHAMAS' RESPONSE TO PREVENT SPREAD.

Janeen Bullard, Sandra Buckner, and Scott Johnson: Design Elements Ltd (Consultant to the Department of Marine Resources), Consultant, Bahamas National Trust. P.O. Box N9816, Nassau, The Bahamas.

In early August 2013, the Cane Toad aka Marine Toad (*Rhinella marina*) was found on the western end of New Providence. It was first thought the appearance of a single cane toad, but further sightings, and evidence of breeding confirmed the presence of the species. The cane toad is a very toxic species able to produce a toxin capable of killing small pets and causing severe skin reactions in humans. Knowing the fecundity of the species, swift action had to be taken to control the potential spread of the toad throughout New Providence and possibly The Bahamas. In order to eradicate the species, the strategy addressed the following:

- Establishment of a task force;
- The capture and destruction of all life stages by a core team;
- Development and distribution of educational material; and
- Training of support staff in the identification and handling of cane toads.

Community members became the greatest asset in the fight against the cane toads as they reported sightings and collected animals. Since eradication efforts have begun hundreds of cane toads have been collected while several invaded ranges that housed toadlets were discovered. All specimens were euthanized and properly disposed of. What we do know is that they are reproducing and we have to continue to work to control and possibly eradicate the species. There have been confirmed sightings outside of the original confined area and unless a greater effort is made to eradicate the cane toad it is believed that they will spread throughout New Providence and other islands. The introduction of the cane toad leads us to question as to whether the nation's borders are being managed effectively.

Keywords: Bahamas, eradication, control, invasive alien species, cane toad, strategy

14. MAINTAINING OFFSHORE ISLANDS IAS FREE IS A VIABLE STRATEGY FOR PROTECTING ENDANGERED ENDEMIC SPECIES

Krauss, U.; Isidore, L.; Jn Baptiste, T.; Lesmond, S; James, M.; Hunt, S.; Petersen, L.; Dornelly, A.; Joseph, A.; Williams Peter, S.; Morton, M.; John, L.; Bobb, M.

The Pointe Sable Environmental Protection Area (PSEPA) encompasses 1,038ha of land and sea, including a marine reserve, a bird sanctuary, both Saint Lucian Ramsar sites and three offshore islands: Scorpion Island, Maria Minor, and Maria Major. Of these, Maria Major contains the most biodiversity of global importance, including five endemic reptiles. One of these species, the Saint Lucia racer snake (*Liophis ornatus*) is believed to be the world's rarest snake. A 2011 racer survey estimated the global population below 120 individuals and recommended a Red List reassessment from EN to CR. This high endemism and small populations at a vulnerable, single site are of serious concern, with IAS constituting a major threat. Feral goats were removed from the island several decades ago and mammalian predators have never been established on the Maria Islands. The mammalian IAS-free status has to be actively maintained. Prior to MTIASIC, the Durrell Wildlife Conservation Trust and SLFD eradicated rats on three other off-shore islands to allow translocations of whiptails and the establishment of a metapopulation: Praslin (1995) and Rat Island (2008); repeat translocations occurred during 2009-2013. The rat-free status of all these islands is maintained through a network of sentinel rat bait stations and regular monitoring. This approach for the whiptail is working well and reduces the risk of extinction. Replicating this approach for the racer in future would require islands that (1) are (or can be made) free of invasive species that present a risk to the SL racer's survival and (2) are large enough to support enough lizard prey for the racer to survive. Invasive species of primary concern are non-native mammalian predators, but the occurrence and risk presented by non-native parasites and pathogens should also be assessed. The pilot project built capacity among practitioners in biodiversity monitoring and inventoring, raised awareness among both local community stakeholders and the general public of the dangers posed by IAS, and established monitoring guidelines and a rapid response plan in case new aliens are detected by quarantine officers and port workers.

Keywords: Saint Lucia; Ramsar Sites, Racer Snake, *Liophis ornatus*, Invasive Species, conservation

15. RESTORING BIODIVERSITY TO ISLA ALTO VELO AND ISLA CATALINA, DOMINICAN REPUBLIC, THROUGH INVASIVE VERTEBRATE REMOVAL: AN ASSESSMENT OF CHALLENGES AND OPPORTUNITIES

Kirsty Swinnerton¹, Jose Luis Herrera¹, Yolanda León², Carlos Rijo³, Francisco Núñez⁴, Nelson García³ ¹Island Conservation, 650 East Bay Street, Nassau, New Providence, Bahamas. ²Grupo Jaragua, Calle El Vergel 33, Ensanche El Vergel, Santo Domingo, Distrito Nacional, República Dominicana. ³Ministerio de Medio Ambiente y Recursos Naturales, Cayetano Germosén esq. Av. Luperón, El Pedregal, Distrito Nacional, República Dominicana. ⁴Francisco Núñez, The Nature Conservancy, Avenida 27 de Febrero esq. Winston Churchill, Plaza Central, 3er Nivel, Local B-339-B, Santo Domingo, Dominican Republic.

Worldwide, invasive species eradication is increasingly being used as a valuable conservation tool with which to successfully restore island biodiversity. Two offshore islands in the Dominican Republic, Isla Alto Velo and Isla Catalina, offer significant opportunities to restore historical seabird colonies, protect island endemic reptiles, provide native species refuges free from the impacts of invasive vertebrates, and increase eco-tourism benefits. The biodiversity and ecological integrity of these two protected areas are threatened by the impacts of at least five different invasive vertebrates: rats, cats, goats, raccoon, and rabbit, the removal of which was identified as potential pilot projects for the MTIASIC program. However, a preliminary feasibility assessment to remove invasive mammals from Isla Alto Velo indicated that, due in part to the challenging logistics of the island's remote location, insufficient funding was available within the MTIASIC program to complete eradication. In addition, after initial site assessments on Isla Catalina, eradication planning was not progressed further in part due to the extensive tourism that exists on the island which presents significant operational and biosecurity challenges. However, in 2013 a partnership between the Ministry of Environment and Natural Resources, Grupo Jaragua, and Island Conservation provided an opportunity to further the restoration of Isla Alto Velo under a CEPF-funded project. During the next 15 months, the project partners will build on the feasibility assessment and develop a science-based operational strategy and a funding plan to complete the removal of cats, rats, and goats from the island. In addition, while the complete removal of all invasive vertebrates from Isla Catalina is not currently being planned, the removal of invasive raccoon from the island is considered a critical action to prevent the species' establishment on the island of Hispaniola and the consequent devastation of native and endemic biodiversity in the Dominican Republic and Haiti.

Keywords: Dominican Republic, Invasive Species, bio security, conservation, rats, goats, racoon, rabbit

16. PREVENTING THE INTRODUCTION OF AN INVASIVE ALIEN SPECIES, FROSTY POD ROT (CAUSAL ORGANISM, *Moniliophthora roreri* (CIFERI & PARODI) EVANS ET AL.): THE TRINIDAD AND TOBAGO EXPERIENCE

Deanne V. Ramroop. Research Division, Ministry of Food Production, Trinidad and Tobago.

Frosty pod rot (FPR) caused by *Moniliophthora roreri* (Ciferi & Parodi) Evans et al., is a highly destructive cacao disease. The disease is present in Venezuela and thus poses a serious threat to Trinidad & Tobago and other Caribbean countries. It is a disease of significant economic importance, since it can reduce crop yield by 60% and has the potential to decimate the cocoa industry. Trinidad and Tobago is the home of fine flavoured Trinitario cocoa and the International Cocoa Genebank (ICGB). Country activities were aimed at protecting the cocoa growing areas from *M. roreri* through the strengthening of the capacity for detection and interception of the disease at various points of entry; establishment of systems and protocols for the speedy eradication of the disease if detected together and the continuous monitoring of the ports of entry and cocoa growing areas for the presence of the disease. A public education and awareness campaign to heighten familiarity with Invasive Alien Species (IAS) and FPR in particular together with emergency action plan was also developed. Two field surveys were conducted in Trinidad and Tobago during the 2010 and 2013/2014 cropping seasons to determine the presence of frosty pod rot. A total of 275 cocoa fields were surveyed during 2010 survey and the disease was not found to be present. The 2nd survey was conducted during the pod season (November 2013 – January 2014) to reconfirm that *M. roreri* is not already present in Trinidad. A total of 273 farms were randomly selected with a minimum sample size of 30 farms/county (Trinidad) and 15 farms (Tobago). Farms surveyed were mapped using a Garmin GPSMAP hand held unit and data analyzed using SPSS Statistics. Frosty pod rot was not found to be present in Trinidad and Tobago. The prevention of FPR from invading the cocoa resources of the Caribbean is of critical importance to the economic well-being and bio-diversity of Trinidad and Tobago. Early detection is essential to management of this destructive disease if it reaches T&T. A number of cultural, chemical, and biological strategies have been tested for

the control of FPR, however, a more integrated management strategy using biocontrol agents and resistant planting material is envisaged in the future.

Keywords: frosty pod rot, cocoa, cacao, cocoa disease, *Moniliophthora rorei*, invasive alien species

17. USE OF THE NATIVE HISPANIOLA BLACK CARPENTER BEES (*Xylocopa mordax*) AS POLLINATOR AGENT OF THE TOMATO CROP IN GREENHOUSES: A POTENTIAL LOCAL ALTERNATIVE TO THE INTRODUCTION OF BOMBUS BEE SPECIES

Guerrero, Kelvin A. Jonathan Eslowys, Fernández Liranzo, DimasCanela, José A. Universidad Agroforestal Fernando Arturo de Merino (UAFAM), Jarabacoa, República Dominicana.

The Ministry of Environment and Natural Resources has expressed interest in finding a local native species to serve as an alternative to the introduction of bumblebees for greenhouse producers in the Dominican Republic. These producers prefer bumblebees as a pollination agent for the tomato crop in greenhouses. It has been well documented that the introductions of these species of bumblebees have become a threat to native pollinators in the countries in which such species have been introduced. The proposed research seeks to determine the feasibility of using the Hispaniola black carpenter bee (*Xylocopa mordax*) as a pollinator agent for the tomato crop in the greenhouse industry in the country. To conduct such investigation, we will study a pollinator's farm in order to determine nesting niches, the abundance of food sources and habitat to ensure reproduction, and the abundance of the species. In the laboratory, we will study the biological history of the species at different temperatures to determine rates of fecundity, fertility, longevity, etc. To assess pollination capabilities, we will liberate female individual of the Hispaniola black carpenter bees in greenhouses with a tomato crop and evaluate the pollination activity under protected environment. The expected result of such study is to have a native pollinator to avoid the introduction of the species of the genus *Bombus* in the country. Meanwhile, some preliminary data will be presented about the development of such research.

Keywords: *Xylocopa mordax*, tomato, greenhouse, pollinators, Dominican Republic

18. THE NATIONAL INVASIVE SPECIES STRATEGY FROM 2003 TO NOW: ITS EVOLUTION AND IMPLICATIONS FOR RESPONDING TO IAS IN THE BAHAMAS

Stacey Moultrie and Janeen Bullard. HD Wells Professional Planning Services, Postal address: P.O. Box N9727, Nassau, The Bahamas.

The first National Invasive Species Strategy (NISS) for The Bahamas was developed and approved in 2003. This first NISS was developed through stakeholder collaboration and led by the BEST Commission with support from international agencies focused on invasive species, such as the Global Invasive Species Programme (GISP), Invasive Species Specialist Group (ISSG) and the Islands Initiative. The work was funded by The Bahamas Government and the Environment Project Fund of the Foreign and Commonwealth Office (FCO) of the British Government. The first NISS built on initial work completed under the Inter-American Biodiversity Information Network Invasives Information Network (I3N) Project in which databases on invasive species, expertise and programmes were developed and made accessible on the Worldwide Web. The 2003 NISS was the first response of the Government of The Bahamas in recognition of IAS as a very real threat to Bahamian biodiversity and had several successful outcomes. The NISS outlined basic concepts of invasion, including mechanisms for control and management. A Code of Conduct for Government agencies as well as voluntary codes of conduct for specific sectors, such as farms and aquaria was developed. The first list of known IAS in The Bahamas was publicized and the NISS recommended twelve basic actions for implementation of the Strategy. This NISS was revised in 2013 and continues the trend of stakeholder collaboration. Its revision was led by the Department of Marine Resources (DMR). The 2013 NISS details management objectives related to collaboration, prevention, early detection and response, control, monitoring, education and awareness, research, policy and legislation and economic tools. Key highlights of the revised Strategy include the role of Customs in IAS management and an implementation strategy spanning the time period 2013 – 2023 with a number of ongoing tasks.

Keywords: Bahamas, control, invasive alien species, management, strategy

19. WWW.CIASNET.ORG INFORMED IS FOREARMED IN THE BATTLE AGAINST INVASIVE SPECIES.

Naitram Ramnanan¹ and **Avenesh Ali**². ¹Regional Representative and IAS Coordinator, CAB International. ² Web Developer/Consultant.

The Caribbean, designated as one of the world's biodiversity hotspots¹ spans 4.31 million km² of ocean and 0.26 million km² of land. It supports extremely diverse marine, freshwater and terrestrial ecosystems of global ecological and economic importance. Invasive Alien Species (IAS) are a major threat to this vulnerable biodiversity to the people depending on it for their livelihoods. The Global Environment Fund provided funding for a regional project: Mitigating the Threats of Invasive Alien Species in the Insular Caribbean. Component three of this project is geared to addressing the lack of information to control and manage IAS in the Caribbean. The website ciasnet.org is expected to be one of the lasting legacies of this project. The website has been expanded to be a one stop shop for information on IAS in the Caribbean with additional funding from the USDA/APHIS and the Critical Ecosystems Partnership Fund (CEPF) for its continued development. The site will not only host documents and a database of IAS in the Caribbean but also provide a registry of professionals and host regular training events to continuously build capacity. This site is a communal virtual space for national agencies and organizations, regional and international organizations working on IAS to promote their actions targeting IAS and highlight their successes. The paper describes the following functions of the site in managing and controlling IAS in the Caribbean: Policies and Strategies: Regional and national policies and strategies are highlighted. Prevention: data on potential new species so that agencies can enhance their capacity to prevent entry of new IAS. Eradication: an example from the Dominican Republic is highlighted. Management and Control: information is provided on IAS that is having large impacts. Regional coordination: a list of key agencies engaged in IAS in the region.

Keywords: internet, invasive species, Caribbean, information, public awareness

Day Three. Wednesday 2 April 2014

SESSION THREE: APPROPRIATE PRACTICES FOR ERADICATION, MANAGING AND CONTROL OF IAS IN THE CARIBBEAN

20. MTIASIC BAHAMAS LIONFISH CONTROL PILOT PROJECT: FINDINGS AND MANAGEMENT IMPLICATIONS

Nicola Smith^{1,2} and **Krista Sherman**³ ¹Earth to Ocean Research Group, Department of Biological Sciences, Simon Fraser University, Burnaby, B.C., V5A 1S6, Canada (present address). ²Department of Marine Resources, Ministry of Agriculture, Marine Resources & Local Government, East Bay St., P.O. Box N-3028, Nassau, Bahamas. ³Science and Policy, Bahamas National Trust (BNT), P.O. Box N-4105, Nassau, Bahamas.

Invasive lionfish (*Pterois volitans* and *P. miles*) are now established in many parts of the western north Atlantic and Caribbean Sea, and pose a significant threat to the ecology, economy and public health of island states. Given its abundance and widespread distribution, complete eradication of lionfish is unlikely. However, attempts are currently underway throughout the region to curb lionfish population growth and spread. A pilot experiment on four islands (Andros, Eleuthera, Exuma Cays and New Providence) in three habitat types (i.e. mangrove creeks, coral patch reefs and nearshore recreational areas) to develop control strategies for lionfish. Experiment objectives included: 1) to determine the extent of lionfish colonization in mangrove creeks, 2) to evaluate the effectiveness of different lionfish removal frequencies on lionfish abundances in mangrove creeks, coral patch reefs, and nearshore recreational areas (i.e. beaches and marinas), 3) to assess the effectiveness of different lionfish removal frequencies on the recovery of native fish communities in mangrove creeks and coral patch reefs, and 4) to build national capacity in reef fish monitoring and research. Over a two-year period, a combination of belt transects and modified roving diver surveys were used to assess both lionfish and native fish communities. Lionfish were manually removed via netting and spearing on either a quarterly, bi-annual or annual basis, depending on habitat and island. Our findings in mangrove creeks revealed that: 1) lionfish do not frequently occur in mangrove creeks of the central Bahamas, 2) when present in mangroves, lionfish densities were relatively low compared to other habitats 3) lionfish recolonization rates following manual removals were slow, and 4) lionfish were likely to reside in mangrove creeks with high native fish diversity. In contrast, lionfish densities were higher and their recolonization rates following removals were faster in both coral patch reefs and nearshore recreational areas than in mangrove creeks. Furthermore, in coral patch reefs, biannual lionfish removals appeared to be as effective as quarterly removals in reducing lionfish abundances in the absence of major natural disturbances (i.e. hurricanes). Similar to other studies, more than 50% of lionfish in our study consumed native fish, including ecologically and economically important species. Overall, the effectiveness of different lionfish removal frequencies varied depending on habitat, experiment duration and the occurrence of natural disturbances. The MTIASIC project also substantially enhanced national capacity in reef fish monitoring through a series of comprehensive training workshops, which were complemented by monthly proficiency dives over one year. Successful management of lionfish in The Bahamas will require: 1) adopting the most suitable removal frequencies based on habitat type; 2) consistent monitoring, research and public education; 3) continued partnerships with government, NGOs, academia and the public sector; and 4) a long-term, sustainable financing plan.

Keywords: *Pterois volitans* and *P. miles*, lionfish, ecology, fish density, invasive species, management

21. SAVING CARIBBEAN ENDANGERED SPECIES BY REMOVING INVASIVE VERTEBRATES – EXPERIENCES FROM THE ISLA CABRITOS PILOT PROJECT

Kirsty Swinnerton¹, Jose Luis Herrera¹, Carlos Rijo², Robert Ortiz³, and Jorge Brocca^{3,1} Island Conservation, Nassau, The Bahamas and Santa Cruz, California, US.² Ministry of Environment and Natural Resources, Santo Domingo, Dominican Republic ³ Sociedad Ornitológica de la Hispaniola, Santo Domingo, Republica Dominicana.

The Insular Caribbean is a globally important biodiversity hotspot with high levels of endemism. Island endemic species are particularly vulnerable to the impacts of invasive alien species; worldwide about 80% of species extinctions have occurred on islands, with invasive species as one of the leading causes. We have documented six taxa of the most damaging invasive vertebrates inhabiting at least 123 Caribbean islands which are home to 265 IUCN-listed Critically Endangered, Endangered, and single-island endemic species. Caribbean Rock Iguanas (*Cyclura* sp.) are one of the most endangered taxa in the world, and Isla Cabritos (Dominican Republic) is the only site where two *Cyclura* species co-exist; the Ricord's Iguana (*Cyclura ricordii*) and Rhinoceros Iguana (*Cyclura carinata*). However, five invasive vertebrates are known from the island: rats, mice, cats, donkeys, and cattle, which significantly impact the iguanas and degrade the subtropical dry forest habitat. The removal of invasive vertebrates from Isla Cabritos was selected as a pilot project for the MTIASIC program and implemented through a collaboration of international and local non-profit organizations and the Government of the Dominican Republic. To-date, 134 donkeys and more than 200 invasive cats have been removed from the island. However, the removal operations could not be completed within the timeframe of the MTIASIC program and the project does not yet have a successful outcome. Using our experiences from this project, we provide recommendations for future invasive vertebrate removal operations which include: appropriate budget development at project initiation; availability of adequate funding to complete the project; a robust knowledge of the eradication environment prior to operational planning; social acceptability of methodologies proposed; and implementation of documented best practices for invasive species removal. We hope that this project will continue to completion so that the resources applied to-date have not been wasted.

Keywords: Dominican Republic, restoration, endangered species, invasive alien species, eradication

22. THE JAMAICAN IGUANA – FROM REDISCOVERY TO RECOVERY

Byron Wilson¹ and Kimberly Stephenson² ¹Department of Life Sciences, University of the West Indies, Mona, Kingston 7, Jamaica, and ²Jamaican Iguana Research and Conservation Group.

Rock iguanas are the most imperiled lizards in the world, and the Jamaican iguana is arguably the most endangered species. Once considered extinct, *Cyclura collei* was re-discovered in 1990. The most ominous factors thought to prevent survival of individuals were predation by introduced mammals and loss of the iguana's remaining dry forest habitat. There has been a six-fold increase in the wild breeding population since 1991. This dramatic recovery is attributed to two primary interventions aimed at Mitigating the Threat of Invasive Alien Species (IAS): (1) continuous IAS predator control in the core iguana conservation zone, and (2) the release of captive-reared, 'head-started' iguanas. During the period of the MTIASIC project, the JIRG has expanded trapping and monitoring in the core iguana zone and surpassed the release of the 200th 'head-started' individual into the wild. The group was also able to continue ongoing research and conservation projects, as well as facilitate four botanical surveys that expanded the species list for the Hellshire Hills. Despite these efforts, the major threats that may have initially driven the Jamaican iguana to the brink of extinction still exist, and are even more pressing than ever.

Keywords: Jamaica, iguanas, *Cyclura collei*, invasive species, predators

23. AN ASSESSMENT OF CONTROL METHODS FOR INVASIVE ALIEN IGUANAS IN SAINT LUCIA

Krauss, U.; Isidore, L.; Mitchel, N.; Seely, L.; Alfred, P.; Ramessar, A.; Johnny, A.; Joseph, B.; James, M.; Dornelly, A.; Breuil, M.; Vuillaume, B.; Morton, M.; John, L.; Bobb, M.

The Saint Lucian Iguana is the largest native terrestrial animal on Saint Lucia. It gave the island its Arawak name: *Iyanola* - Land of the Iguana - and has become a valuable flagship species that represents a globally threatened habitat type in the insular Caribbean. DNA and morphological studies suggest that the iguanas on Saint Lucia are a unique population, found only on this island and deserve subspecies status. In 2008 a threat to the uniqueness of the Saint Lucia iguana was identified: an exotic iguana was reported in the wild near Soufriere, presumably originating from escaped pets that were smuggled into the country illegally. Several impacts of this species are feared: hybridization with the Saint Lucia iguana, competition for food and habitat, vectoring pests and diseases, and upsetting the local ecosystems and agriculture. Currently the two species are geographically isolated, which could provide an opportunity for eradicating the aliens if a cost-effective method is identified in time. Population viability modeling using VORTEX suggest that extinction probability of the alien depends on when it first established, on juvenile mortality and hunting pressure applied. Reasonable assumptions lead to eradication likelihoods of 30% to 90%. Thus, alien iguana eradication in the Soufriere area is probably feasible if moderate removal rates can be achieved before estimated current populations explode. However, currently available methods do not achieve the required rates. Over the entire project duration, the capture rate of detected iguanas was 60%. Capture success, following residents' prompt reports of sightings, were 100%, but the mobilization campaign probably needs to target residents who stay largely at home in order to increase timely calls. An Iguana Alert Network was set up in a strive for post-project sustainability. Attempts to attract iguanas to bait, traps or nest sites were unsuccessful. A single season trial with a detector dog suggests that this approach could be effective in locating iguanas in difficult terrain, even if they rest in the tree canopy. The SLFD and Durrell have drafted a 5-year Species Action Plan for the native iguana in 2013, through a participatory process.

Keywords: Invasive Species, Saint Lucia, control methods, iguana

24. PUBLIC HEALTH CONCERNS FOR CAPTURE AND CONSUMPTION OF LIONFISH IN JAMAICA

Dayne Buddoo, Marine Biologist, Lecturer and Academic Coordinator, Discovery Bay Marine, Laboratory Centre for Marine Sciences, University of the West Indies, Jamaica.

Consumption of the lionfish across the region has been employed as one of the strategies to combat the rapid spread of the species. There are three main concerns to public health that were considered in this study: envenomations, ciguatera and heavy metals. Case studies of envenomations have shown victims suffering from predominantly pain and swelling, while others have shown infections and even residual spines in body. Incidents of stings have significantly reduced and these have been mainly from training programmes (targeting fisher and divers) in the safe capture and handling of the lionfish. There have been no reported cases of lethal effects of a lionfish sting. Samples of lionfish tissues from several locations around Jamaica were tested by the National Ocean and Atmospheric Administration (NOAA) in the United States. Based on the results obtained, there is no recommendation of a change in strategy of using consumption to control the lionfish populations. Samples of lionfish were also tested for 25 essential, non-essential and toxic elements. All samples were shown to have a molar excess of selenium. In addition the suggested selenium health benefit value was calculated, and was positive for all samples. It was concluded that *P. volitans* appears to contribute modestly to mineral and trace element nutrition, while not being a significant contributor to dietary exposure of toxic elements.

Keywords: lionfish, food safety, public health, ciguatera, heavy metals, envenomations, selenium

25. BUILDING A SUSTAINABLE NATIONAL MARINE PROTECTED AREA NETWORK: CONTROLLING LIONFISH POPULATIONS IN MARINE PROTECTED AREAS

Krista Sherman¹, Craig Dahlgren², Stacey Moultrie³, Frederick Arnett⁴. ¹Science and Policy, Bahamas National Trust (BNT), P.O. Box N-4105, Nassau, Bahamas. ²Perry Institute of Marine Science, Perry Institute for Marine Science, 100 N. US Highway 1, Suite 202 Jupiter, FL 33477, USA. ³SEV Consulting Group, P. O. Box N-1416, Nassau, Bahamas. ⁴Department of Marine Resources, P. O. Box N-3028, Nassau, Bahamas.

Marine protected areas (MPAs) are typically designed to conserve biodiversity through the preservation of species and their habitats. Invasive species have the potential to reduce the biodiversity of marine communities through predation, interspecific competition, the introduction of diseases, and habitat alteration and degradation. Indo-Pacific lionfishes invaded the Atlantic over a decade ago and have successfully established populations throughout the Atlantic and Caribbean Sea. Given their rapid reproduction rates, generalist diet and capacity to reduce native fish recruitment and densities, invasive lionfish populations must be managed within MPAs in order to maintain ecosystem resiliency. A population control experiment was conducted in six mangrove sites and 26 coral reef sites to determine the most effective removal frequencies (i.e. semi-annual or quarterly) for managing lionfish within two Bahamian MPAs — the South Berry Islands Marine Reserve and the Exuma Cays Land and Sea Park. The effect of quarterly and semi-annual lionfish removals on lionfish and native fish populations and community structure was examined for up to three years using a combination of belt transects and modified roving diver surveys. Preliminary findings indicate that quarterly removals are most effective for reducing lionfish populations, with significant effects detected after the first year of removals. Marine protected area managers should incorporate the most appropriate control strategies for lionfish into their MPA management plans and monitoring programmes.

Keywords: marine protected areas, Invasive Species, lionfish, population control

26. THE ANATOMY OF THE *Perna Viridis* INVASION IN TRINIDAD AND TOBAGO

Rosemarie Kishore¹ and Chevelia Chase². ¹ *Institute of Marine Affairs, Hilltop Lane Chaguaramas.* ² *Department of Agricultural Economics and Extension, Faculty of Food and Agriculture, University of the West Indies*

The first known marine IAS in Trinidad was the green mussel, *Perna viridis*, introduced in 1990 either via ballast water or through fouling of hulls of commercial ships. . This study documents the invasion of *Perna viridis* through an examination of its current distribution and community structure in selected habitats as well as from a study on the economic costs of *Perna viridis* in industrial cooling systems. Comparisons were made amongst habitats surveyed, using the condition factor and morphometric measurements of the green mussel collected, multidimensional scaling (MDS) plots and the use of biological indices. For the economic assessment, data was collected through a census directed at nine (9) firms and was used for a descriptive analysis. The population of the green mussel is still largely restricted to the west coast of Trinidad with a very recent introduction on the north coast the main habitat of the green mussel is now pier pilings with mussel beds no longer existing and populations on the decline. From the economic assessment, the results indicated that six of the nine firms had their operations significantly affected specifically by the marine invasive *Perna viridis* and the fouling of the species in its peak years of invasion (1990 – 2003) has been responsible for as much as 60-90% of their maintenance costs. Although the ecological assessment revealed that the species has naturalised and the population declined within recent times, firms have used *Perna viridis* as a catalyst to put control mechanisms in place to help avoid heavy infestation of fouling organisms including any potential marine IAS. Their sustained presence at port facilities however, facilitates the continued spread of the green mussel to other countries via trade. In an effort to raise the level of awareness and promote synergies among the marine IAS stakeholders particularly those of the industrial sector, a consultation workshop facilitated sharing of information through presentations and working groups discussions. Interactions, information and lessons learnt from the MTIASIC project were also shared with the GloBallast Partnership Project, an international sustainable initiative which will Likewise this study shows the need to implement regional preventative strategies to deal with the impact of global shipping a major pathway for the introduction of marine IAS.

Keywords: *Perna viridis*, marine IAS, fouling organism, Trinidad, water cooling system

27. TOBAGO'S FRESHWATER AIS: THEY CAME, THEY STAYED AND NOW THEY SPREAD!

Ryan S. Mohammed^{1,2}. ¹Department of Life Sciences (DLS), Faculty of Science and Technology (FST), The University of the West Indies (UWI), St. Augustine, Trinidad. ² Aquaculture Association of Trinidad and Tobago (aQua-TT).

It was previously believed that Tobago was spared from the presence of freshwater AIS. It is now observed that there are at least three aquatic invasive snail species (*Melanooides tuberculata*, *Tarebia granifera* and *Pomacea diffusa*) and one fish species (*Oreochromis* sp.). Monitoring survey results over a five year period of the island's freshwater are charted to indicate the spread of these animals across the island. Of particular interest, firstly, is *Pomacea diffusa* which was only recently documented and appears to be localized to the south of the island. Secondly, the presence of the two turret snail species is providing a resource to the rocky shore hermit crab community in the north of the island. Thirdly, there seems to be an isolated habitat that is currently a haven for AIS in the south of Tobago. Potential alien threats such as the terrapin, *Trachemys scripta elegans*, the prawn, *Macrobrachium rosenbergii* and the crayfish *Cherax quadricarinatus* will also be discussed with regards to aquaculture and ornamental pet trade practices.

Keywords: *Melanooides tuberculata*, *Tarebia granifera*, *Pomacea diffusa*, Invasive species, Tobago, freshwater ecosystem

28. ASSESSING THE EFFECTIVENESS OF DIFFERENT HERBICIDES IN THE CONTROL OF MELALEUCA TREES AND SAPLINGS

Kurt McLaren and Kurt Prospere. Department of Life Sciences, Faculty of Science and Technology, University of the West Indies, Mona Campus, Kingston 7, Jamaica, W.I.

Three experiments were established on April 2012, February and March 2013, to determine the effects of different herbicide treatments on *Melaleuca quinquenervia* tree and sapling mortality in the Black River Lower Morass, Jamaica. Experimental plots were established according to a randomized block design in three patches of *M. quinquenervia* trees. For two of the three patches, the experimental design included three blocks consisting of four 10 x 10 m plots each, with each plot being assigned to one of the following treatments: 50% Arsenal, 50% Roundup and 25% Arsenal, 50% Velpar and a control. For the third patch, three blocks consisting of two 10 x 10 m plots each were established, and each plot was randomly assigned as either a 100% roundup treatment or as a control. The herbicides were applied to the trees after they were frilled, while for the trees in the control plots, no herbicides were applied after frilling. A total of 1033 trees were sampled throughout all the treatment plots. The application of both the Arsenal and Arsenal and round up herbicides resulted in a 98% - 100% mortality of trees. This was significantly higher than the percentage mortality recorded for the Velpar (0 – 28%) and control plots (0%). Approximately two-thirds of the trees in one of the two experiments were burnt inadvertently; but burning had no effect on mortality. Additionally, the application of 100% Round-up herbicide treatment resulted in 100% mortality of *M. quinquenervia* trees, which was significantly higher than the control plots (0%).

Keywords: Invasive species control, herbaceous wetland, Jamaica

29. THE EFFECTS OF PATCH SIZE AND INVASIVE PLANTS ON THE DIVERSITY AND STRUCTURE OF A TROPICAL SWAMP FOREST

Kurt Prospere, Kurt McLaren and Byron Wilson. Department of Life Sciences, Faculty of Science and Technology, University of the West Indies, Mona Campus, Kingston 7, Jamaica, W.I.

A total of 20, 20 x 60, and 38, 20 x 20 m permanent sample plots (PSPs) covering a total area of 3.92 ha were established within 10 of the last remaining swamp forest patches found in the Black River Lower Morass, Jamaica, to assess the impact of invasive plants on the composition and structure of trees. All trees ≥ 2 cm DBH were tagged and diameter at breast height (DBH) was measured and the trees were either identified in situ or identified using voucher specimens at the Department of Life Sciences' herbarium. The level/extent of different types of anthropogenic disturbances (burning, cutting and invasive species presence) was quantified within each plot. Two ordination methods were used to determine the effects of various anthropogenic disturbances and swamp forest patch size on species composition and structure.

Key words: tropical swamp forest, invasive species, anthropogenic disturbance

30. RED PALM MITE, *Raoiella indica* Hirst (ACARI: TENUIPALPIDAE): A THREAT TO MORICHE PALM (*Mauritia flexuosa*) IN THE NARIVA SWAMP OF TRINIDAD AND THE PURSUIT OF INTEGRATED PEST MANAGEMENT STRATEGIES

Farzan Hosein, Seepersad Ramnarine, Christine Omadath, Khaliqa Mohammed, Tavia Bando, Safraz Ali, Roopnarine Singh. Ministry of Food Procution, Trinidad and Tobago.

The Red Palm Mite (*Raoiella indica*) is a severe invasive pest that affects economically and ecologically important plants in nurseries, landscape areas as well as plants in the natural environment of Trinidad and Tobago. It is a threat to a range of plant species within the Nariva Swamp inclusive of palm species (Arecaceae) and Zingiberales (Heliconiaceae, Musaceae, and Zingiberaceae). The Nariva Swamp located along the east coast of Trinidad is an Environmental Sensitive Area and designated as a wetland of an international importance. Within the swamp, palms comprise a major component of the vegetative biodiversity under different ecological environments. To determine the distribution of palm species and the incidence of Red Palm Mite the swamp was divided into coastline, intermediate and inland areas. GPS data were used to map the accessible palms clusters found in the three areas. Clusters of 10 palm species together with coconut (*Cocos nucifera*) were surveyed at three different canopy levels to determine the incidence of the mite on the fronds. Moriche Palm (*Mauritia flexuosa*) and coconut were severely affected by the mite as all growth stages of these palms were had high populations of mites and symptoms of yellowing and necrosis. Natural enemies found associated with the mite included low population levels of the predatory mite *Amblyseius largoensis* and lacewing (Chrysopidae). Under greenhouse conditions, Moriche seedlings became severely infested and exhibited symptoms of yellowing, necrosis. Healthy seedlings are important for the natural regeneration and sustainability of the Moriche Palm in the swamp, which is many important species are dependent upon, including the blue and yellow (*Ara ararauna*) and red-bellied (*Ara macao*) macaws. In view of the importance and economical benefits derived from Moriche and coconut, the adoption of integrated pest management using various control strategies, including Biological agents will be proposed for the mite within the Nariva swamp.

Keywords: Mites, Invasive Species, Red Palm Mite, Nariva Swamp, Palm species, Coconut, Moriche Palm, *Raoiella indica*, biological control, Lacewing, *Amblyseius largoensis*

31. *Acacia mangium*, AN INVASIVE SPECIES WITH POTENTIAL FOR REHABILITATION OF ABANDONED QUARRIES

Seepersad Ramnarine. Forestry and IAS Consultant, Trinidad and Tobago.

In 1984, the Forestry Division of the Government of Trinidad and Tobago took part in an international trial of *Acacia mangium* Willd. This species was introduced at Erin, Mount Harris, Moruga, Arena, Cumuto, Valencia and on the Northern Range at Matura, Melajo, St Michael, La Baja, La Rue Pomme, and Chaguaramas. On the Northern Range, acacia was introduced to reforest denuded hillsides and further utilized in the reforestation of abandoned quarries. At Mount Harris and Moruga the species did not spread beyond the planted area. At all other locations acacia has spread beyond the planted area into the surrounding forests. As a result of its rapid growth, reproductive potential and ability to cover sites in less than three years, the species poses a serious threat to natural habitats. In areas that are subject to frequent fires in the dry season, acacia has become invasive. In areas that are not fire prone, acacia poses a lower risk of becoming invasive. Despite this invasive tendency, the species performs well in the rehabilitation of abandoned quarries and denuded hillsides of the Northern Range.

Keywords: *Acacia mangium*, Trinidad and Tobago, land rehabilitation; Invasive Species

32. IS TEAK (*Tectona Grandis* L.) AN INVASIVE SPECIES IN TRINIDAD AND TOBAGO?

Seepersad Ramnarine. Forestry and IAS Consultant, Trinidad and Tobago.

The introduction and naturalization of teak (*Tectona grandis*) in Trinidad has been considered a phenomenal success. To date approximately 9,000 hectares were established and harvests from intermediate and final fellings generate revenues of 8-12 million TT annually and provide raw materials for the wood working industries comprising of sawmillers, licensed wood workers, furniture manufacturers and logging contractors. However, the negative impacts of teak establishment are loss of biological diversity, annual fires and accelerated soil erosion, increased runoff and loss of hunting habitats. The revenues generated from the sale of teak per ha minus the cost of establishment and maintenance including the cost of fire protection, road construction and other infrastructure along with the loss of topsoil, loss of biodiversity, and other ecosystem services reveals that investment in teak plantations results in a net loss to the investor. In addition, teak is also displaying signs of invasiveness

Keywords: Teak, Trinidad and Tobago, Invasive Species, Biodiversity

DAY 5. Friday April 4, 2014

Friday SESSION FIVE: EFFECTIVELY COMMUNICATING TO THE CARIBBEAN PUBLIC TO ACHIEVE FEWER IAS INTRODUCTION AND LOWER SPREAD

33. SPEAKING IAS - EFFECTIVELY COMMUNICATING THE MESSAGE

Nelsa English-Johnson and Caryl Grant. *Mitigating the Threat of Invasive Alien Species in the Insular Caribbean Project*, Projects Planning and Monitoring Branch, National Environment and Planning Agency, Jamaica.

Invasive Alien Species (IAS) are among the leading drivers of biodiversity loss in Small Island Developing States. Each individual has a role to play in protecting biodiversity from the impact of invasive alien species. The methods of communicating this role to ordinary stakeholders determine the success or failure of conservation efforts. In Jamaica, Knowledge, Attitudes, and Practices (KAP) Surveys were used to inform the planning and implementation of all public awareness campaigns. This ensured that the correct message; using the most appealing/effective method(s) of information dissemination were utilized based on the target audience. An important step was the translation of the conservation message from pure science to one that was personalized, humanized and easily publicized. In Jamaica, the most effective methods of sharing the IAS message included the use of catchy phrases; high impact printed materials (posters, car sunshades/visors and factsheet) and school based competitions (debate, song/DJ and poetry). These were delivered through expositions, road shows, sports days, social media and summer camps. A key aspect of the various campaigns was the issuing of keepsakes (notebooks, tote bags, T-shirts and car sunshades/visors). Most importantly these keepsakes were branded with IAS messages that would be spread by virtue of an individual utilizing these products. These tokens were disseminated as a reward, only after individuals had listened to or participated meaningfully in an IAS activity.

Keywords: Invasive Alien Species, public awareness, Jamaica

34. TRAVELLERS DON'T PACK A PEST OUTREACH PROGRAM

Wayne DeChi, Agricultural Officer, USDA/APHIS.

Don't Pack a Pest Outreach Program (DPAP) is aimed at educating travellers about the risks associated with bringing in agricultural products in their baggage that may harbour harmful pests and diseases. Outreach program is the result of partnership between Florida Department of Agriculture and Consumer Services (FDACS), United States Department of Agriculture (USDA) and Department of Homeland Security/Customs and Border Protection (DHS/CBP) to improve inter-governmental cooperation in carrying out agricultural safeguarding activities in Florida ports of entry and beyond. A video and signage have been developed to educate travellers about the risks associated with bringing undeclared items such as plants, fruits and vegetables, meat or animals into the US. The proposed concept involved using a CBP agriculture detector dog to deliver the message. The program began in 2010 with the production of the video, initial placement of signage at the Miami International Airport. In 2011-2012 the Travellers "Don't Pack a Pest" Outreach Program continued with the expansion of the partnership to include the Caribbean Region. The video produced and distributed via: YouTube; Florida TV Stations; Agency links; and in May 2012 it was shown in American Airlines. Signage created for multiple uses: billboard located on expressway to Miami airport and Dioramas throughout airport. Don't Pack a Pest in the Caribbean: Outreach material was modified to reflect a regional message and broaden safeguarding efforts beyond Florida and the United States of America; In April 2012 a partnership was initiated with Jamaica Ministry of Agriculture (JMOA). The program was launched in Kingston and Montego Bay in airports and cruise ship ports, involving Ministry of Tourism and Port officials, on October 2012. In March 2013 the Dominican Republic Ministry of Agriculture confirmed its partnership with Don't Pack a Pest ("*No empaque plagas*"). The message was translated into Spanish. The program is starting in two international airports (Las Americas and Puerto Plata) and the Ferry and Cruise ship Ports. Formal launch of the program is scheduled for March 27th, 2014.

Keywords: agricultural products; agricultural pests; air travel; quarantine; Caribbean; United States of America.

35. PROTECTING BLACK RIVER'S BIODIVERSITY-PRESERVING OUR LEGACY THE BLACK RIVER AREA SOCIAL MARKETING CAMPAIGN

Nelsa English-Johnson and Caryl Grant. *Mitigating the Threat of Invasive Alien Species in the Insular Caribbean Project, Projects Planning and Monitoring Branch, National Environment and Planning Agency, Jamaica.*

A 2011 Knowledge Attitudes and Practices survey of the Black River Watershed revealed that 55.3% of respondents had insufficient knowledge of the environment. Only 11% of respondents knew what Invasive Alien Species (IAS) is and of that number only 5.6% viewed IAS as actually being harmful to the environment. The survey recommended the implementation of a public awareness campaign using creative methods and partnerships. The Regional Mitigating the Threats of Invasive Alien Species in the Insular Caribbean Project provided participating countries with training on use of social marketing as a tool to bring about behavioural change towards IAS impacting the environment. As a consequence each country was to plan and implement a campaign in their respective countries. The Black River Watershed was chosen as Jamaica's project. Six communities within the Black River Watershed were targeted. The bottom-up participatory approach was used in planning the activities through community focus group meetings and local government committee meetings. The results of the KAP were shared and a plan for improving the knowledge, attitudes and practices towards the environment devised by the residents for implementation. Three main activities were planned and executed, namely a road show and concert; expo and sports day; and installation of a permanent Black River's Treasures display over a 5 month period. Evaluation surveys showed an improvement in knowledge with only 14% of those surveyed indicating that they had insufficient knowledge of the environment and 91% indicating an accurate knowledge of IAS.

Keywords: Invasive Alien Species, social marketing campaign, behavioural change

36. COMMUNICATION STRATEGIES FOR ALIEN INVASIVE SPECIES

Wilhelmina Kissoonsingh and Deokie Bholasingh-Hay. Extension Division, Ministry of Food Production. Trinidad and Tobago.

This case study paper examines the communication strategies used in the management of two Alien Invasive Species to Trinidad and Tobago namely the Pink Hibiscus Mealy Bug (PMB) *Maconellicoccus hirsutus* and the Giant African Snail (GAS) *Achatina fulica*. Archival reports were used to determine the communication strategies used in managing these Notifiable Pests of public importance. Studies have shown that the key to success of an eradication/management programme is Public Awareness. The results of the study indicated that communication campaigns were used in both circumstances. Initially messages were communicated to sensitize those affected by the pests. However, as the problem grew, structured media campaigns involving a combination of radio, television, print, video, electronic bulletin boards and training seminars were utilized to involve the public.

Keywords: communication campaigns, communication methods, public awareness, invasive species

37. “EDUTAINING” THE CARIBBEAN ON IAS – AN EFFECTIVE TOOL IN THE COMMUNICATION BOX

¹Chike Farrell, ¹Cordell Lawrence, ²James Amow, ²Belinda Caruth and ³Naitram Ramnanan. ¹Caribbean Ideas; ²Publicis; ³CABI Caribbean and Central America.

The papers provides a brief literature review on the use of today’s increasingly prevalent digital channels and a story-telling approach as a method for more effectively building awareness and understanding of public-health related issues among target audiences, particularly younger audiences who are overloaded by information. The papers outline how the digital channels may be utilized to not only deliver key messages to segments of the population that may otherwise be more expensive / difficult to reach, but also how an approach based on engagement and entertainment performs in raising understanding of complex issues. Specifically it describes a digital game: Pest Files. The gamer/player assumes the role of a pest detective using clues that are both informative and engaging in describing how Invasive species enter, spread and how they can be controlled. Players are provided with up to three clues in varying degrees of clarity/difficulty to identify the Pest. Points are awarded based on their ability to more quickly identify the pest / utilize less clues. Players can avail themselves of a “pest wiki” containing more detail on the pest in order to use fewer clues, which in the process helps deliver information about the pest and pest control, helping to achieve the macro objective. A link on the wiki also takes the gamer to CABI’s Invasive Species Compendium where full up-to-date data sheet exists or where the player has access to full details on close to 2000 data sheets, many of which are present and affecting the Caribbean. The primary method that will be used to determine the effectiveness of this method as a strategy for disseminating critical information to change behaviours will be pre-and post surveys among target audiences and age groups. Results are presented and discussed for the trial period March 10-25 as an indication of utility and cost effectiveness of the method.

Keywords: games, digital channels, information, entertainment, invasive species, behavioural changes

SESSION SIX: BUILDING AND SUSTAINING AN EFFECTIVE IAS NETWORK ACROSS THE WIDER CARIBBEAN

38. A NETWORK OF CROP PROTECTION SPECIALIST AND POLICY MARKERS FOR THE PROTECTION OF CARIBBEAN PLANT RESOURCES: THE CARIBBEAN PLANT HEALTH DIRECTORS (CPHD) FORUM

Wayne De Chi, Agricultural Officer , USDA/APHIS.

In 2007, the Caribbean Plant Health Directors (CPHD) Forum was formed with the main goal of to increase communication and foster transparent exchange of phytosanitary information among Caribbean countries and entities. The annual CPHD Forum contributes significantly to this objective via individual and group interchanges that takes place at and between meetings. The main support for this forum is from the United States Department of Agriculture Animal and Plant Health and Inspection Services (USDA / APHIS) and CARICOM, with support from the Inter-American Institute for Cooperation on Agriculture (IICA) and the Food and Agriculture Organization (FAO). Over the last 5 years the CPHD Forum increased its collaborative efforts and unified its strategies to strengthen plant health safeguarding throughout the Greater Caribbean Region. With support from its partner agent USDA APHIS - GCSI, IICA, CARICOM FAO, CARDI and CABI, its membership has expanded beyond CARICOM Member States and Associated Member States, to include non CARICOM Countries and entities such as Aruba, Dominican Republic, Cuba, Curacao, Martinique, St. Maarten, Turks and Caicos Islands, US Virgin Islands and Organismo Interacional Regioanl de Sanidad Agropecuaria (OIRSA). The Forum also serves as the technical resource base which proposes recommendations on matters of safeguarding against or minimizing the impact of plant pests and diseases to the region’s agriculture and environment. It envisions becoming the Region’s Plant Protection Organization and is working to achieve this status including the decommissioning of the Caribbean Plant Protection Commission (CPPC). Some significant achievements to date include: more than 200 technical personnel in the region trained in areas such as the identification of insect orders Hemiptera / Homoptera, Coleoptera, Heteroptera, Lepidoptera, Thysanoptera; Mollusks, plant diagnostics etc. Provide diagnostic equipment to Member States (Barbados,

Guyana, Jamaica, Cayman Islands and Trinidad and Tobago) and increase video conferencing equipment to all the IICA Offices in the Region. Draft a Manual on Red Palm Mite. An evaluation of the Fruit Fly Trapping Programme in the Caribbean region was completed with country specific recommendations for improving the programme. A set of datasheets for the identification, prevention, control and/or eradication of the following palm pests / disease - Lethal Yellowing; Coconut Cadang-Cadang; Viroid; Red Palm Mite; Red Ring Nematode; and Red Palm Weevil were completed. The seven meeting will take place from July 28th – 1st August 2014 at the Marriott Hotel, Grand Cayman In 2014.

Keywords: Caribbean, plant protection, government agencies, cooperation, safeguarding, agriculture, environment

39. NETWORKING STAKEHOLDERS FROM KEY BIODIVERSITY AREAS INTO A VIRTUAL CARIBBEAN NETWORK FOR INVASIVE ALIEN SPECIES

Rafique Bailey¹ and **Naitram Ramnanan**² ¹Regional Coordinator, Caribbean Invasive Species Network, CEPF Project.

²Regional Representative and IAS Coordinator, CABI CCA.

The Caribbean area is regarded as a biodiversity hot spot. The Critical Ecosystem Partnership Fund (CEPF) has identified 45 areas as Key Biodiversity Areas (KBAs) within the Caribbean. Of these KBAs several in the following Caribbean states: Antigua and Barbuda, the Bahamas, Dominican Republic, Jamaica and Saint Lucia are threatened by Invasive Alien Species. CABI, with funds from the Global Environment Facility in cooperation and collaboration with UNEP and a wide range of national and regional organizations have been implementing between September 2009 and March 2014 a regional project: Mitigating the Threats of Invasive Alien Species in the Insular Caribbean. One of the outputs of this project is the regional collaboration on IAS and the establishment of a virtual network: the Caribbean Invasive Species Network. In 2013 the CEPF granted some funds to CABI to execute a project: Regional Networking and Strategy Development for Invasive Alien Species in Priority Key Biodiversity Areas. This project will strengthen stakeholders capacity to conduct surveillance for IAS threats and to advocate appropriate action to curtail these threats to the KBAs. Additionally, the project will undertake several key actions that will identify the major IAS and their impacts on the KBAs. These will include: (1) establishing an online skills register for experts working in IAS control and management to facilitate greater networking (2) Identify skills gaps and address these via regular webinars and discussions forum to facilitate exchange of experiences among stakeholders across countries on managing IAS and protecting biodiversity and (3) host national and regional stakeholder workshops to strengthen networking and facilitate exchange of experiences as well as mainstream IAS issues at national and regional levels. The output of the regional conference: Policies, Strategies and Best Practices for IAS in the Caribbean will inform the action of this project to safeguard the biodiversity of the KBAs from invasive species.

Keywords: Caribbean, biodiversity, collaboration, nongovernmental organizations, experts, networking

40. SUSTAINABLE FORESTRY PARTNERSHIPS

Ingeria Miller. Ministry of the Environment and Housing, Forestry Unit. N-356, Nassau, The Bahamas.

The Pine Forests on Abaco, Andros, Grand Bahama and New Providence are an untapped and important natural resource of The Bahamas. In 2010, the Government of The Bahamas enacted comprehensive forestry legislation for the sustainable management, preservation and conservation of forests across The Bahamas in the form of the Forestry Act, 2010. The Act established a Forestry Unit within the Ministry of the Environment and also created a Forestry Unit. The chief priority of the unit is the sustainable management of pine forests, which contain *Pinus caribaea* (Caribbean Pine), and the revival of the timber industry. By expanding the utilization of The Bahamas' natural resources like the pine forests, the country becomes less dependent on imports and offers green jobs and opportunities, increases the long term economic revenue from the natural pine forests. As the Forestry Unit is still in its embryonic stage, it has formed numerous significant partnerships to assist in fulfilling its mandate, maximizing its capacity, enhancing its growth and ensuring its productivity, including partnerships with The Food and Agriculture Organization (FAO), Global Environment Facility (GEF), The Bahamas National Trust (BNT), and numerous governmental, nongovernmental and

civic organizations. The Forestry Unit has obtained financial and technical assistance to achieve the following goals: to train forestry officers and other interested Bahamians in all aspects of forest management, planning and monitoring of the pine forests (FAO); to undertake a massive land degradation project which has linkages to sustainable livelihoods, GIS mapping and institutional strengthening of key land management agencies (GEF); and in forest management field programmes on Abaco and Andros (BNT). These partnerships have all been extremely advantageous to the Forestry Unit in strengthening its institutional capacity.

Keywords: Bahamas, pine forestry, sustainability

41. ALL HANDS ON DECK: PARTNERSHIPS AT WORK AGAINST AN INVADER

Dayne Buddoo, Marine Biologist, Lecturer and Academic Coordinator, Discovery Bay Marine, Laboratory Centre for Marine Sciences, University of the West Indies, Jamaica.

There is great value of partnerships in managing an aggressive invasive species. The current invasion of the lionfish across the Caribbean region has underscored this fact. In Jamaica, the Global Environment Facility's funded project "Mitigating the threats of Invasive Alien Species in the Insular Caribbean" pumped in much needed financial support within a year of the invasion. Though this was important, the partnerships with government, non-governmental organizations and the private sector ensured that the fight against the lionfish is successful. These organizations contributed to training, scientific research and public relations and outreach. Public interest has shown to be the greatest tool in the effort, and the partnerships have bolstered the resources of the MTIASIC Project. Currently, all sectors with an interest in the marine environment have been engaged in the fight against the lionfish, and this has been identified as one the greatest factors for the continued success of the campaign.

Keywords: partnerships; lionfish; governmental agencies; non-governmental agencies

42. THE LEON LEVY NATIVE PLANT PRESERVE: ITS HISTORY, DEVELOPMENT AND STRATEGIES FOR MANAGING INVASIVE FLORA

Mark Daniels, Bahamas National Trust, The Levy Preserve, Bank's Road, Eleuthera, The Bahamas.

The Leon Levy Native Plant Preserve first opened to the public on March 24th, 2011 as the first National Park on the Island of Eleuthera. Charged with the mission to highlight native plants, showcase herbal medicine, and promote early childhood education, The Levy Preserve covers 25 acres with approximately two miles of trail, supporting more than 270 species of native plants. During the development of The Preserve, priority was given to the removal of invasive flora such as *Casuarina equisetifolia*, *Leucaena leucocephala*, *Jasminum fluminense* and *Schinus terebinthifolius* from disturbed areas of the property. The most problematic of species, *Casuarina equisetifolia*, is processed by The Preserve to create wood chip for trails, planks for benches, tables and signs and as raw material for educational programs and activities.

Keywords: Bahamas National Trust, Eleuthera, herbal medicine, native plants, invasive species

Members of the International Project Steering Committee

BAHAMAS

Mr. Frederick E. Arnett II

National Coordinator/Assistant Fisheries Officer
Department of Marine Resources
East Bay Street
Nassau, The Bahamas
Tel: (242) 393-1777; Fax: (242) 393-0238
Email: farnett.dmr@gmail.com

Mr. Michael Braynen

Director, Department of Marine Resources
East Bay Street
P.O. Box N-3028, Nassau
The Bahamas
Tel: (242) 393-1777; Fax: (242) 393-0238
Email: michaelbraynen@bahamas.gov.bs

DOMINICAN REPUBLIC

Mr. Carlos Rijo Güilamo

National Coordinator
Viceministerio de Areas Protegidas y Biodiversidad
Cayetano Germosén esq. Av. Luperón, El Pedregal, D.N.
República Dominicana
Tel: (809) 567-4300 Ext. 7382; Mobile: (809) 501-9455
Email: carlos.rijo@ambiente.gob.do

Mr. José Manuel Mateo

Director of Biodiversity and Wildlife
Viceministerio de Areas Protegidas y Biodiversidad
Cayetano Germosén esq. Av. Luperón, El Pedregal, D.N.
República Dominicana
Tel: (809) 501-4182
Email: jose.mateo@ambiente.gob.do

JAMAICA

Mrs. Nelsa English-Johnson

National Coordinator
Mitigating the Threat of Invasive Alien Species in the Insular
Caribbean Project
National Environment and Planning Agency (NEPA)
10 Caledonia Ave, Kingston 5
Jamaica
Tel: (876) 754-7540 ext. 2319; Mobile: (876) 579-7884
Fax: (876) 754-7595; Skype: nelsa.english
Email: nelsa.english@nepa.gov.jm

Ms. Sheries Simpson

Manager, Projects Planning & Monitoring Branch
National Environment and Planning Agency
10 Caledonia Avenue, Kingston 5
Jamaica
Tel: 1-876-754-7540 Ext. 2336
sasimpson@nepa.gov.jm

SAINT LUCIA

Dr. Ulrike Krauss

National Coordinator
Project Director and Chief Forest Officer
Forestry Department
Gabriel Charles Forestry Complex
Ministry of Sustainable Development, Energy, Science and
Technology
Tel: (758) 4468-5646; Fax: (758) 450-2287
Skype: ulrike_krauss; Email: saintlucia.ias@gmail.com

Mr. Michael Bobb

Project Director and Chief Forest Officer
Forestry Department
Gabriel Charles Forestry Complex
Union, Castries
St. Lucia, W.I.
Tel: (758) 4468-5646; Fax: (758) 450-2287
Email: michaelbobb_2000@yahoo.com

TRINIDAD AND TOBAGO

Mrs. Velda Ferguson-Dewsbury

National Coordinator, UNEP-GEF Project
Ministry of Food Production
Research Division
Central Experiment Station
Caroni North Bank Road
Centeno, Trinidad
Tel: (868) 642-9217 (Office/Fax); (868) 292-7478 (Mobile)

Ms. Audine Mootoo

Director- Research Division
Ministry of Food Production
Research Division
Central Experiment Station
Caroni North Bank Road
Centeno, Trinidad
Tel: (868) 646-1646; Email: amootoo@gov.tt

Implementing Agency - United Nations Environment Programme

Ms. Kristin McLaughlin

Global Environment Facility (GEF) Liaison Officer & Task Manager
United Nations Environment Programme (UNEP)
900 17th Street, NW -- Suite 506
Washington DC 20006 USA
Tel: 202-974-1312; Fax: 202-223-2004
skype kristin.mclaughlin; Email: kristin.mclaughlin@unep.org

Regional Executing Agency - CAB International

Mr. Naitram (Bob) Ramnanan

Regional Representative and IAS Coordinator
CABI Caribbean & Central America
Gordon Street, Curepe
Trinidad and Tobago
Tel: (868) 645-7628/662-4173; Fax: (868) 663-2859
Mobile: (868) 367-1252; Email: n.ramnanan@cabi.org
Skype: bob.ramnanan

