Invasive alien species (IAS): Concerns and status in the Philippines

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Introduction

The Philippines consists of about 7,107 islands with a total land area of approximately 30 million hectares, with human population estimate of more than 80 million. The country is characterized by an irregular shape and nearly all the islands have rugged uplands in the interior. From the original forest of 30 million hectares only 6.16 million hectares of the land are now under forest with less than a million hectares of virgin forest left. The ecosystem is characterized by a high degree of biological diversity. However, population pressure, poverty and survival needs have resulted in rapid destruction of the environment. In recent years, the increasing global trade, travel, and transport had rapidly increased the rate of introduction and diversity of alien species.

Invasive alien species (IAS) includes exotic or non-native micro- and macro-species introduced, accidentally or deliberately, to a place that is not part of their natural habitat or distributional range, and have adverse ecological and economic impacts (Bruton and Merron, 1985; De Silva 1989). Exotic species, especially those that were introduced to an area with no natural predators or competitors, will flourish in their new habitats. Once established, introduced species can become aggressive and dangerously invasive. Studies have demonstrated that IAS could alter the evolution of native species by competitive exclusion, niche displacement, predation, and ultimate extinction (MacKinnon, 2002). In a few cases, the exotic species have hybridized with closely related species and have transmitted diseases harmful to both animals and humans (Vitousek et al. 1997). IAS are among the top drivers of environmental change globally, and are known to threaten food security, human health, and economic development.

In the Philippines, data on the impact of IAS on native biota are scarce, and limited to a number of anecdotal reports indicate that native species may be adversely affected through competition, predation, habitat alteration, and parasitism. Impacts of IAS in the

Philippines is poorly understood because of lack of knowledge about taxonomic identity of IAS and also lack of extensive and comprehensive technical information; failure to realize the potential ecological damage to Philippine biodiversity and consequent economic losses and possible hazards to human health; failure of implementation of laws on introduction of exotic species; and unwillingness to interfere in the commerce and trade of exotic species.

Most of the information on IAS is on their mode of introductions: intentional and /or accidental. The introduction patterns and trends are directly linked to natural resource policy, trade, travel, and transport. The introduction pathways are attributed to one or any combinations:

(1) Transport of organisms to a new habitat-between islands or countries
(2) Establishment and propagation of IAS in the new habitat- either in natural or man-made habitats, such as enclosures, artificial ponds, reforestation areas, and gardens
(3) Uncontrolled spread from initial population over large area- either through deliberate release or accidental escape

In the country, early introductions were intended for food production, reforestation, horticulture, and recreation. Human actions are the primary means of IAS introductions, usually for economic reasons, and without a careful consideration of the full costs involved. However, more efforts are needed in future to create awareness in the people on the negative impacts of IAS on local biodiversity.

This paper presents the information available on IAS in the Philippines, their impacts and concerns.

Status of IAS and their impacts

The IUCN Invasive Species Specialist Group (ISSG)'s Global Invasive Species Database(GISD) lists 47 alien species that have been introduced to the Philippines, 6 with biostatus uncertain, and 23 that are native to the Philippines region and invasive elsewhere (ISSG, 2006a). The species of concerns currently are described below as case examples in aquatic and terrestrial ecosystems. Some of them are included in the list of 100 World's Worst Alien Invasive Species (Lowe et al., 2000). Seven of the worst invasive plant species that are found in the Philippines are: *Chromolaena odorata*, *Eichhornia crassipes*, *Hiptage benghalensis*, *Imperata cylindrica*, *Lantana camara*, *Leucaena*

leucocephala, and *Mikania micrantha* (ISSG, 2006a).

1. Invasive aquatic plants

There have also been introductions of aquatic exotic micro-and macro-flora into the country that have not been recorded. However, many exotic freshwater macrophytes have been introduced for ornamental purposes. The ones of national concern are as follows:

(1) Water hyacinth (*Eichhornia crassipes*). It is labeled as the "ecosystem engineer" or "invasive habitat modifier" and its invasiveness is related to clogging waterways, impeding boat transport and fishing activities, and reducing fisheries productivity (MacKinnon, 2002). Their dense monospecific mats lowers dissolved oxygen levels in the water. This weed species has covered at least 20% of the water surface of Laguna de Bay in the 1980s and caused heavy damage on the fish pens and cages during typhoons. It is also considered a nuisance as it reduces phytoplankton growth and food of fish, thereby affecting fishing and aquaculture activities in major lakes in the Bicol Region.

(2) Water fern (*Salvinia molesta*). This floating aquatic fern aside from being a pest in the irrigated rice fields (Sinohin and Cuaterno, 2002), also negatively affects the biodiversity and abundance of freshwater species including fish and submerged aquatic plants, and thus affects fishing activities, and boat travels.

(3) Water lettuce/ Duck weed (*Pistia stratiotes*). It is an invasive free floating weed capable of forming dense mats on the surfaces of lakes, ponds, rivers and other bodies of water. Also common in rice fields, but its biostatus is still uncertain..

Three species of invasive alien microalgae, *Cochlodinium polykrikoides, Alexandrium minutum* and *Chattonella marina*, are known to be associated with harmful algal blooms in the coastal waters of Palawan and Pangasinan.

2. Invasive aquatic animals

(1) Golden apple snail (*Pomacea canaliculata*). Originally introduced to increase the protein source of Filipino diet, but now a major pest hindering the promotion and adoption of direct-seeded rice. This snail is also blamed to displace the native edible snail, *Pila conica,* in Luzon (Pagulayan, 1997). Chemical control of the snail pest with imported molluscides was estimated to be valued at US$23 million in

1984-1998 (Joshi, 2005). It is also a vector of rat lungworm parasite that affects humans. This freshwater mollusc is a truly IAS, as its utilization as food is less than its population in natural waters. Presently, a book on the "Global Advances on the Ecology and Management of the Golden Apple Snails" with contributors from different geographical regions is being edited by R. C. Joshi and L. S. Sebastian, Philippine Rice Research Institute (PhilRice), Philippines.

(2) Fishes. In the Philippines, twelve exotic aquatic organisms with invasive reports and their impacts are summarized (Table. 1). On the other hand, Juliano et al. (1989) and Guerrero (2002) have reported more than 40 introductions of fish, crustacean and mollusc species since 1907.

There are nine exotic species found in the country but records of their establishment and distribution in natural waters are not clearly known. Most of these are popularly sold as ornamental fishes in pet shops and their potential impacts are highlighted (Table 2).

Their negative impacts can be summarized as follows: competition for food, reduction of the population of native fishes, occurrence of potential new pathogenic parasites, pollution of major lakes, and eutrophication of lakes and reservoirs.

Three invasive freshwater fishes in Philippine lakes have been previously reported by Juliano *et al*. (1989). These species are the indigenous white goby (*Glossogobius giurus*) and the eleotrid (*Hypseleotris agilis*) which were accidentally introduced in Lake Lanao, and the exotic Asiatic/Thai catfish (*Clarias batrachus*). The two former species are responsible for the loss of the endemic cyprinids in Lake Lanao, Mindanao; while the catfish is believed to have displaced the native catfish (*Clarias macrocephalus*) in Luzon.

More recently, the South American sucker mouth catfish or "janitor fish", earlier identified as *Plecoptomus hypoglosus* and later verified to be *Pterygoplichthys pardalis* and *P. disjunctivus* have become invasive in the Marikina River (Metro Manila), Lake Paitan in Cuyapo, Nueva Ecija and Laguna de Bay (Agasen, 2005). Introduced by the aquarium trade industry, the species escaped into natural waters. Damage to the banks of the Marikina River and fish cages in Laguna de Bay by the nuisance catfish is claimed. A bounty system for the eradication of the "janitor fish" has been launched by the City Government of Marikina. The live fish is brought at the price of ₱5 per kilogram and then destroyed. A World Bank-funded project for the conversion of the species into fishmeal is being implemented by the Laguna Lake Development Authority in cooperation with a farmer's cooperative in Laguna.

The Louisiana crayfish introduced as an ornamental species in the late 1990s may become a truly invasive species if it escapes to natural waters. It consumes aquatic plants and this may include rice plants. In Spain, it has become invasive in rice fields and pesticides are used to control it.

Only last year, the presence in Lake Taal (Batangas) of the "jaguar guapote" (*Parachromis managuensis*), a piscivorous cichlid from Central America, was reported by Agasen (2005). Believed to have been introduced as an aquarium fish the species has become established (naturally breeding) and invasive. Fishermen of the lake have reported a decline in their catch of indigenous fish species as the white goby (*G. giurus*) and the theraponid (*Therapon plumbeus*) as well as that of the introduced Nile tilapia (*Oreochromis niloticus*). Considered as a threat to the indigenous and endemic fishes of the lake, increased fishing effort to eradicate the "jaguar guapote" has been recommended.

Mosquito fish (*Gambusia affinis*) is locally known as "bubuntis" or nicknamed as million fish they are prolific breeders. It is a live-bearer, meaning fully-grown fish are produced instead of eggs by females. It spawns throughout the year and feeds on zooplankton. The fish was introduced from Hawaii in 1905 to the Philippines primarily for mosquito and malaria control. It consumes mosquito larvae. This species is also predating on the eggs of fry of dojo in Banaue rice terraces. It is abundant in canals, rice fields, and other water bodies. They are of economic importance because of their pest status in fish farms as they are competitors of the fish being cultured. In pet shops, they are being sold as fish for arowana and other carnivorous fish. If available in abundance, it can serve as a source of fish meal.

3. Invasive vertebrates

It is not known how many species of vertebrates used as pets have become feral. In general, it is likely that migrating people using inter-island boats may have carried with them some species of amphibians, reptiles, birds and mammals, but there is not enough information documenting these events.

(1) Rodents. Four species of non-native rodents (*Rattus exulans*, *Rattus tanezumi*, *Rattus tiomanicus* and *Rattus agentiventur*) are invasive pest in the Philippines, that were most likely carried *via* boats docking at various seaports. *Rattus argentiventer* is a species that occurs in Mindanao and other islands of the Philippines, but not in

Luzon (or if so, it has not become established). If it was to become established in the main rice bowls of Luzon then the impact could be severe. The breeding ecology of this species is closely aligned with the growing season of rice (Personal communication: Dr. Grant Singleton, IRRI, Philippines).

(2) Lizards. Five species of geckonid lizards widely distributed and closely associated with human habitations were also probably transported by man through inter-island boats. Soft-shelled turtles used as food have at times escaped to the wild. It is suspected that the leopard cat (*Prionailurus bengalensis*) may have been introduced because of its curious disjunct distribution being present in Negros and Palawan, but absent in Mindanao and Luzon. Its occurrence in sugarcane fields (an artificial habitat for wildlife) is in contrast to the other carnivores (civet cat and palm civet), which are found only in original forests or their remnants.

(3) Birds. Two species of invasive birds have been introduced into the Philippines, *Padda oryzivora* and *Passer montanus.* They are believed to compete with related species, though it has never been adequately documented.

(4) Frogs. Five species that have been introduced into Philippines with negative impacts are as follows:

Neotropical Giant Marine Toad (*Bufo marinus* L.) was introduced into the Negros islands in 1934 by the Bureau of Plant Industry from Hawaii to control beetles in sugarcane fields. It has spread to numerous islands across the Philippines through subsequent introductions both accidental and deliberate in nature. Its impacts on the native amphibian fauna remains to be studied thoroughly. However, there is some evidence that it competes with three native frog species in the lowlands (*Rana cancrivora, Polypedates leucomystax* and *Kaloula conjuncta negrosensis*) in terms of breeding sites and depositing its eggs in ponds.

American Bullfrog (*Rana catesbeiana* Shaw) was first bred in Montalban, Rizal in 1960's to boost food production. Few years later, this government project collapsed and 14,000 adults and tadpoles were released in Lake Paoay and Lake Billoca, northern Luzon and Ligawasan Marsh, Mindanao, respectively. It is known to be voracious predator on other amphibian species in the United States.

Taiwanese frog, *Hoplobatrachus rugulosus* (Weigmann) was also introduced for commercial farming. After escaping confinement, it is now widely distributed in the Southern Luzon. It has been reported to pose risks to several species of small native

frogs in lowland areas.

Common green pond frog, *Rana erythraea* (Schlegel) found on some islands of the Philippines has been introduced because of its disjunct distribution (Negros, Panay, and Laguna).

Brown bullfrog, *Kaloula pulchra* (Müller) is the most recent inroduction.

The reasons for the introduction of *R. erythraea* into the country is unclear. Among the species, *B. marinus* and *H. rugulosus* exhibit the highest population densities and are the most geographically widespread.

4. Invasive invertebrates

(1) Plant pest organisms. Agriculture is one the most vulnerable sectors to IAS since human actions are the primary means of their introductions. Since 1978, there are about fifteen IAS included in the preliminary list of 30 introduced species based on bibliographic search.

The species that have attained invasive status for the past 5-10 years are: Buff coconut mealy bug, *Nipaecoccus nipae*, infesting coconuts, bananas and other economically important crops and forest species. The long leaf beetle, *Brontispa longissima* attacks coconuts and other palms. The rice black bugs, *Scotinophara* spp. expanding its distribution in many islands of the Philippines. Several species of leaf miner flies, *Liriomyza* spp. imported with cut flowers have attained outbreak levels destroying potato crops and other highland crops in Benguet and Mountain provinces. Similarly, the spiraling whitefly, *Aleurodicus dispersus* affects many vegetable crops and ornamentals; Leucaena psyllid/ Jumping plant lice, *Heteropsylla cubana* affects almost 100% of *Leucaena leucocephala* crop country-wide. Big-headed ant (*Pheidole megacephala*) that hauls rice seeds in the upland environment, is also an introduced pest. Several species of scale insects, mites and gall wasp of dapdap, *Quadrastichus erythrinae* Kim. have also become invasive. The most recent introductions are those that affect the corn in Mindanao (*Stenocranus pacificus*), the oil palm nursery in Mindanao (Mycoplasma?) and the coconut in Luzon and in Samar *(Brontispa longissima*). Origin or means of introduction into the Philippines are not exactly known but most of them are suspected to be riders of imported plants or plant products.

The invasive species can be products of both introduction and indigenousness. The Philippines is an island, and thus, a pest problem in one Philippine island for many years,

now invading another islands of the Philippines is a good case of invasive species. For example, in rice, the white stem borer (*Scirpophaga innotata*) in Iloilo, Philippines has been a chronic rice pest for many years and now invades upland rice in Claveria, Mindanao islands. Except for the rice black bugs, *Scotinophara* sp. and S. *latiuscula*, all rice arthropods listed are exotic pests that must have landed into the Philippines by multiple pathways: airplanes, boats, plant materials, hitch hikers, etc. (Table. 3). It is hard to provide full documentation but once their origin is known then their status can be justified. The orchid virus (*Oncydium* sp.) and the potato cyst nematode (*Globodera rostochiensis*) are seriously affecting orchid and potato industry in the Philippines.

(2) Non-native earthworms. There are several species of earthworms that are invasive non-native ones and to mention a few are as follows: *Pontoscolex corethrurus* (origin Brazil), *Polypheretima elongata* (origin SE Asia, probably Indonesian region), *Amynthas corticis* (origin mainland E Asia), *Dichogaster saliens* (origin Africa), *Nematogenia occidentalis* (origin unclear), *Perionyx excavatus* (origin India). The "giant earthworms" or "Mystery worm" (*Pheretima* spp./ *Metaphire* spp.) destroy the rice terrace walls by burrowing holes, and causing water stress and encouraging weed growth thereby affecting rice production in Banaue rice terraces (Personal communication: Dr. Samuel James, USA).

5. Invasive non-aquatic plants

Numerous alien plant species have successfully invaded natural and human-altered habitats through deliberate and accidental introductions in the Philippines within the past 400 years. Merrill (1912) notes on introduced plants included in the Flora of Manila, revealed that 50% of the 1,007 species listed had been introduced by man, and of these non-indigenous plants, half are spontaneous, i.e., have become naturalized, while the other half are cultivated only. Alarmingly, 334 species, about a third of the plants in the Flora of Manila, have been brought into the country fairly recently, 242 of which were introduced deliberately and 92 introduced accidentally. Their unrestricted proliferation has had many dire consequences, including crop loss (in the case of agricultural weeds), decrease in biodiversity and deterioration of overall environmental quality.

MacKinnon (2002) reported that many ornamental plants are aggressively spreading out of control across the ASEAN region. These include *Caesalpinia pulcherrima* and climbing plants such as Blue Trumpet Vine (*Thunbergia grandiflora*), Morning glory (*Ipomoea carnea*), *Ipomoea cairica, Bougainvillea spectabilis* and the

edible Thai vine (*Coccinea indica*). These plants can smother the original vegetation. Exotic colonizer shrubs such as *Piper aduncum, Mimosa pigra* and prickly pear *Opuntia monacantha* have also been reported to cover huge areas of the region. Nature reserves and parks in Luzon, Philippines, are dominated by the admittedly attractive South American shrub (*Pachystachys coccinea*).

Several species of Australian *Eucalyptus* spp. and two species of *Acacia* (*Acacia auriculiformis* and *Acacia mangium*) grow well in South East Asia and spread naturally over cleared and burned areas. These species have been associated with the forest firescape, a disturbance regime linked to timber loss and displacement of natural forests (MacKinnon, 2002). While these exotic species are present in the country, there has apparently been no assessment regarding the negative impact of the invasiveness of the species.

Exotic tree species in the country that are considered invasive (at least because they are also host of insect pests includes: *Gmelina arborea, Acacia mangium, Eucalyptus camaldulensis, Swietenia macrophylla*.

Forest tree species planted in the country were identified as bioinvasive based from local and international sources: There are eight species, namely: Mahogany (*Swietenia macrophylla*), Giant ipil-ipil (*Leucaena leucocephala*), Palosanto (*Triplaris cumingiana*), Acacia/Auri (*Acacia auricauliformis*), African tulip (*Spathodea companulata*), Aroma (*Aroma confusa*), Mesquita aroma (*Prosopis juliflorae*) and Paper mulberry (*Broussonetia papyrifera*). The *B. papyrifera* was introduced in 1935 to increase the bast-fibre species present in Mt. Makiling but because of its good adaptive and competitive characteristics and several number of dispersal agents, this species appears to be obnoxious and an environmental threat.

Hagonoy, *Chromolaena odorata* native to tropical America, is a serious agricultural weed in the Philippines preventing the establishment of other forage species, thus reducing the availability of edible plants for livestock. It has also been reported to poison livestock due to its allelopathic properties. During the dry season, thick dried stands of the species are undeniably fire hazards. The most commonly used methods to deal with infestations are through manual slashing and use of herbicides. Biological control is also reported to be quite effective, including the use of the stem gall fly *Cecidochares connexa* (ISSG, 2006b) and other natural enemies such as *Pareuchaetes pseudoinsulata*, and eriophyid mite, *Acalitus adoratus*, which have both successfully

established in the Philippines since their arrival in the 1980's.

Cogon grass, *Imperata cylindrica* is a native species that has infested several million hectares of the Philippine uplands. In terms of proportion of land area covered, the Philippines is second to Sri Lanka at 17%. A considerable area of potential agricultural or forest land is rendered useless because of the colonization by *Imperata*. It is considered a noxious weed not only because it has resulted in huge crop yield losses but it also changes ecosystem properties. It alters fire and hydrologic regimes, displaces native regenerative plants, reduces control of sedimentation and soil erosion, promotes eutrophication, and changes biodiversity by reducing species recruitment. It is also allelopathic, parasitic, allergenic, unpalatable or toxic to grazing animals, and a host for many plant pathogens and pests. Ways to control cogon include pulling, which is labor intensive, and poisoning with herbicides. Burning alone is discouraged as it stimulates the weed's growth and does not destroy the rhizomes (ISSG, 2005b). The Philippine government, has undertaken the Assisted Natural Regeneration (ANR) approach to improve degraded lands and thus minimize the spread of the grass.

Large leaf lantana, *Lantana camara* was introduced as an ornamental due to its colorful flowers (ISSG, 2006c). It is considered undesirable because it invades pastures and decreases productivity; replaces native forest species after land is cleared for farming, hence preventing succession and restoration, and may even poison cattle when eaten. Lantana stands may be cleared through manual pulling or by burning, but biological control measures exist.

Ipil-ipil, *Leucaena leucocephala* the only invasive tree species reported in several databases, was introduced as forage into the Philippines from tropical America during the Spanish colonial period. This legume was welcomed at first since it made good firewood and provided shade for understory crops. Exacerbating the problem is that during the American regime, ipil-ipil was among the plants frequently used in the reforestation efforts. For instance, during the establishment of forestry and agricultural schools, such as the School of Forestry in Mt. Makiling, Laguna in 1910, *L. leucocephala* was planted, along with other exotic plants, to afforest the school's grassy area. Now, it is considered a bio-invasive species since it forms pure stands which are difficult to eradicate and thus make the land unusable (Baguinon *et al.*, 2005). Ironically, while ipil-ipil is considered an invasive weed in the Philippines, it is regarded as an important and useful tree in many other countries as it can be used as forage, firewood, timber, and fertilizer. It is also ecologically beneficial as it aids nitrogen fixation through its symbiotic

relationship with *Rhizobium*, serves as windbreaker, and assists in the revegetation of degraded hillsides. This species is so important that many countries are trying to find measures to control the insect pest *Heteropsylla cubana* to which *Leucaena* is the host (Nampopeth, 1994). Applying this knowledge, the Philippines could use this insect to control and manage ipil-ipil infestations. Clearly, there is a need to re-evaluate the risk management aspects of this plant.

Mile-a-minute/ Chinese creeper, *Mikania micrantha* is a fast growing, creeping and twining plant that originated from Central and South America and was introduced as an ornamental plant and a cover crop for plantations, and even as airfield camouflage in World War II. It is harmful to other plants in that it kills them by blocking out the light and smothering them. It also competes for water and nutrients and releases chemicals that could prevent the growth of competitors. Another species, *Mikania cordata*, a native of Southeast Asia and Africa, apparently coexists with *M. micrantha* through niche differentiation in terms of some physiological parameters. Control of *Mikania* can be accomplished in several ways. These plants can be removed manually and cut from the trees and plants that they smother. However, this is labor intensive, costly, and not very effective because even small remnants left behind may grow into mature individuals. Herbicides have also been used in an attempt to eradicate infestations but with little success. Therefore, biological control may be the best option, although it would take more research to successfully find the suitable biological control agent.

Policies and laws

The Philippines has been exposed to a number of alien or introduced species in the past 100 years or so. The Bureau of Plant Industry, Plant Quarantine Service obligation as the Philippines national plant health protection organization is to safeguard the agriculture industry from the introduction of exotic pests into the country. The Plant Quarantine Service (PQS) legal authority to regulate quarantine pests is provided in Presidential Decree No. 1433 known as Plant Quarantine Law of 1978. The Law specifically regulates the entry of plant, plant products, and animals that may harbor pests or cause harm to agricultural products.

In 1981, Presidential Proclamation 2146 was issuedconsidering the introduction of fauna (exotic animals) in public and private forest an environmentally critical project. Thus, any undertaking, which included such activities, will require an Environmental Compliance Certificate. Subsequently, other new laws and policies were passed with

stiffer restrictions and/or penalties, such as the Wildlife Resources Conservation and Protection Act or RA 9147 and the National Biosafety Framework, but still focused primarily on the entry of alien or exotic and invasive or environmentally harmful species.

The Republic Act No. 9147 “provides for the conservation and protection of wildlife resources and their habitats;” and for aquatic organisms, the Philippine Fisheries Code of 1988 (Republic Act No. 8550) which tasks the Department of Agriculture through the Bureau of Fisheries and Aquatic Resources (BFAR) with the quarantine, control and monitoring of foreign aquatic species. It states that: “No foreign finfish, mollusk, crustacean or aquatic plant shall be introduced in Philippine waters without a sound ecological, biological and environmental justification based on scientific studies and subject to biosafety standards as provided by existing laws;….”. The Department of Agriculture Fish and Game Administrative Order No. 06, regulates the importation of fish, mollusks, and other aquatic animals (Uriarte, 2005).

In the implementation of Section 10 of RA 8550, the Department of Agriculture issued Fisheries Administrative Orders (FAOs) 207 and 217 in 2001 for “Prohibiting the Importation and Culture of Imported Live Shrimp and Prawn of All Stages” and “Code of Practice for Aquaculture” (which includes the introduction of exotics and GMOs), respectively. The regulation requiring the application of import risk analysis (IRA) for the introduction of foreign crustacean species is provided for in FAO 207.

On April 19, 2002, the Conference of the Parties of the Convention on Biological Diversity (CBD) adopted the guiding principles for Parties in the prevention, introduction and mitigation of impacts of alien species that threaten ecosystems, habitats or species, under Decision VI/23. The Guiding Principles provides the framework for national governments in developing their own policies and strategies on IAS, not only to prevent entry, but also to minimize spread and impact of these species once they have actually been introduced into the environment.

Through a grant from the United Nations Environment Programme (UNEP) to the Department of Environment and Natural Resources (DENR), a comprehensive assessment of the current status of the country's biodiversity, problems, threats, issues and gaps have been identified. One of the threats to indigenous species is IAS, which is recognized in Article 8h of the CBD: "*Prevent the introduction of, control, or eradicate those alien IAS which threaten ecosystem, habitat and species*".

Since the implementation of WTO, movements of commodities accompanied with

the potential movement of plant pests into the country is expected to increase. This scenario has been addressed with the creation of the Sanitary and Phytosanitary (SPS) Agreement in which primary goal is to promote international cooperation to prevent the spread and introduction of plant pests and to promote appropriate measures for their control. As signatory to the WTO and member country of the International Plant Protection Organization, the Philippines is expected to come up with sanitary and phytosanitary measures consistent with the internationally set standard for risk assessment and management of pest associated with imported commodities. One of the most important provisions of the SPS Agreement is pest risk analysis (PRA). The PRA is a very important tool in evaluating the risk involved in the importation of a particular commodity. It determines if the pest should be regulated and what are the appropriate measures that should be developed to address the risk. There are four stages involved in the conduct of risk analysis. The process starts with initiation wherein pest requiring phytosanitary measures or pathways that presents potential hazard or revision in the phytosanitary policies are identified. This is followed by risk assessment which involves evaluation of the probability of entry, establishment and spread and potential economic consequences of the identified quarantine pest. Development of risk management options and risk communication are the third and final stage of risk analysis, respectively. PRA shall be conducted prior to importation of any commodity that has not been previously imported or that is being imported from a particular place for the first time. The Plant Quarantine Service shall issue the import permit after the PRA has been completed. A special body (PRA team) was created to undertake the evaluation, risk assessment and development of the risk management options. A pool of experts from the academe further scrutinizes the results of the evaluation and also provides guidance and recommendations on the scientific aspect of the analysis. Should the importation be permitted, the materials will be subjected to phytosanitary measures identified in the PRA process. It can be treated, grown in isolated area, laboratory analysis, etc. Importation identified as high risk may be monitored or subjected to regular post entry monitoring and observed for presence of exotic pests that may not have been observed in the laboratory testing.

Other programs that are already in place include implementation of quarantine regulations, implementation of Philippine Policy on Biodiversity, implementation of the Guidelines on Planned Release to the Environment of Genetically Modified Organisms and Potentially Harmful Exotic Species, biological control of *Chromolaena odorata* by

gall fly, management of rice black bug through monitoring, mass production, and field application of *Metarhizium*, and the implementation of the Wildlife Act. Baseline research on invasive species is still minimal but the PAWB-DENR has conducted workshops and exhibits to increase awareness among Filipinos of the urgent need to address the growing problem associated with invasive species (Sinohin & Cuaterno, 2003).

Initiatives and recommendations

IAS are a threat that must not be ignored. Programs and policies to prevent, manage and control and if possible reverse, exotic species invasion must be improved. Effective ways to address issues on IAS are: First, to have a common understanding of what it is all about; Second, to establish a unified framework through which transitions (phases/fluxes) and components (actors/structures) are well integrated; Third, to consider the issue employing all available historically proven useful methodologies while keeping options open to new creative approaches; Fourth, to have a concerted effort in solving current problems at the same time ensuring preventive measures are quickly and properly put in place; Fifth, to effectively communicate findings and lessons learned through publications, data basing, conferences and workshops and ; Sixth, to rationalize a more effective scheme for prioritization of funding researches and other activities.

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Table 1. Invasive exotic aquatic species in the Philippines and their impacts.

Common name/ Zoological Name	Distribution	Feeding ecology	Impacts	
			Positive	Negative
1. Mosquito fish *Gambusia affinis*	Widespread. Common in canals, creeks, swamps, ponds, shallow areas of lakes.	Feeds on zooplanktons, small insects and detritus.	Very effective for mosquito control Sold as an ornamental fish	Predate on the eggs and hatchlings of cyprinid loach *Misgurnus anguillicaudatus* Found to compete with indigenous fish
2. Snakehead *Channa striata*	Widespread. Found in canals, creeks, swamps, ponds, shallow areas of lakes	Carnivore. Feeds on fish, frogs, snakes, insects, earthworms, tadpoles and crustaceans.	A food fish with high aquaculture value and commands a good price in the market. Major source of income for local fishermen.	Predate on native species
3. Common carp *Cyprinus carpio*	Widespread. Found in canals, creeks, swamps, ponds, lakes	Omnivore. Feeds mainly on aquatic insects, crustaceans, annelids, mollusc, weed and tree seeds, wild rice, aquatic plants and algae; mainly by grubbing in sediments	Food species that easily reproduces in ponds, lakes, canals and swamps. Source of food and income but there is low consumers acceptability. Popular only in few selected areas of the Philippines. Uproots submerged weeds and creates turbidity that prevents the growth of submerged vegetation.	Compete with indigenous fish Adults uproot and destroy submerged aquatic vegetation.

Table 1. Continued

Common name/ Zoological Name	Distribution	Feeding ecology	Impacts	
			Positive	Negative
4. Mossambique tilapia *Oreochromis mossambicus*	Found in ponds, rivers, swamps and rice fields throughout the country and brackish water areas	Omnivore	A saline-tolerant species suitable for brackish water aquaculture. Source of food and income from brackish water aquaculture. Bred with Nile tilapia *O. niloticus* to develop a better saline tolerant tilapia species good for brackish water aquaculture	Pest in brackish water ponds as it competes with the natural food (*lab-lab*) of milkfish A highly inbred population occurs and has hybridized with the Nile tilapia both in the wild and in captivity
5. Nile tilapia *Oreochromis niloticus*	Widespread in all freshwater bodies	Omnivore	Commercial aquaculture species. The second most important freshwater species contributing to national fish production in the country. Species for export. Source of food and income from capture fisheries for local fishermen. Source of genetic material for breeding	Cage culture of this fish in open waters has caused pollution of major lakes and reservoirs. In natural water, this fish is a competitor of native species. The introduction of new strains might have brought new species of parasites into the country.

Table 1. Continued

Common name/ Zoological Name	Distribution	Feeding ecology	Impacts	
			Positive	Negative
6. Crucian carp *Carassius* spp.	Occurs in shallow ponds, lakes rich in vegetation and slow moving rivers.	Feeds on plants, insect larvae and plankton.	Source of food fish from local fishery but has a low consumers acceptability.	A competitor of native fishes in fresh water.
7. Freshwater mussel *Cristaria plicata*	Occurs in shallow bodies of water like canals, creeks, swamps, ponds, shallow pools of rivers and littoral areas of lakes and reservoirs	Filter feeder	Source of food and income. Biological filter. Can be polycultured with tilapia	Can be a nuisance in ponds as the sharp shells can injure workers when they step on it, hence, poses an occupational hazard.
8. Janitor fish *Liposarcus disjunctivus*	Established in Laguna de Bay, Philippines;		Fish can be processed to fish meal. Fish skin can be dried and used for handicrafts.	Adverse competitor of indigenous fishes. Destroy nets of fish pens and cages
9. Janitor fish *Liposarcus pardalis*	Occur in Marikina river and Lake Paitan		Fish can be processed as fish meal. Fish skin can be dried and used for handicrafts.	Adverse competitor of indigenous fishes. Destroy pens and cages
10. Thai catfish / Walking catfish *Clarias batrachus*	Widespread. Inhabits swamps, ponds, ditches, rice paddies, and pools left in low spots after rivers have been flooded	Carnivore	Major source of food. Source of income and livelihood from local fishery	Has completely dominated natural populations in lakes and rivers and the indigenous *Clarias macrocephalus*. Considered as pest in tilapia ponds

Table 1. Continued

Common name/ Zoological Name	Distribution	Feeding ecology	Impacts	
			Positive	Negative
11. Golden apple snail *Pomacea cananiculata*	Widespread. Found in rice paddies, swamps, ponds, ditches, and other freshwater bodies. Can also be found in brackish water ponds.	Herbivore	Source of human food. Processed as organic fertilizer. Food of ducks and other animals.	Resulted in the decline of rice production in the 1980s as it damaged newly transplanted rice, Major pest of rice. Resulted in the use of another pesticide i.e. molluscicide in rice farming.
12. Guapote tigre / Jaguar guapote *Parachromis managuensis*	This ornamental fish escaped to Lake Taal, Batangas Province, and now established in the lake	Feeds on small fishes and macroinvertebrates	Ornamental fish Food fish	Predator of indigenous fishes in Lake Taal.

Table 2. Exotic species in the Philippines with potential invasive impacts*.

Common name and Zoological name	Environmental occurrence/distribution	Feeding ecology	Benefits	Potential invasive impact
1. Java barb/Tawes *Barbodes gonionotus* (Bleeker, 1850) *(= Puntius gonionotus=Puntius javanicus)*	Well established in rivers and lakes, where it reproduces naturally. Found also in aquaculture ponds	Feeds on plants, insects and detritus.	Source of food and income from local fishery (capture). Can be used as pituitary donor for artificial propagation in aquaculture. Useful as biological weed control for submerged vegetation in lakes and reservoirs.	May consume native aquatic submerged weeds. Competitor of native species.
2. Red piranha *Pygocentrus nattereri*	Common in creeks.	Carnivore. Feeds on insects, worms and fish. Adults feed mainly at dusk and dawn. Medium-sized to large individuals (15-24 cm length) forage mainly at dawn, late afternoon and night up to about 2200H, whereas smaller fish (8-11 cm) are active mainly during the day. Teeth replacement on alternating sides of jaw allows continuous feeding. (Fishbase, 2000)	Ornamental fish and commands high price.	Since its introduction in 1970-1979, no available information on its establishment and invasive impacts. However, this fish is available occasionally in ornamental fish shops. Its powerful dentition can inflict serious bites. A threat to native species.

Table 2. Continued

Common name and Zoological name	Environmental occurrence/distribution	Feeding ecology	Benefits	Potential invasive impact
3. African catfish *Clarias gariepinus*	Found in aquaculture ponds. Accidentally released into the rivers due to overflowing of ponds. Widely tolerant of extreme environmental conditions. The presence of an accessory breathing organ enables this species to breath air when very active or under very dry conditions.	Highly carnivorous. Bottom feeder which occasionally feeds at the surface.	Source of food and income through aquaculture. Highly priced fish.	The introduction of the African catfish to inland waters is proved to have negatively affected the natural stock and indigenous population. Boon in production led to the rapid decrease of prices of other catfish species.
4. Giant snakehead *Channa micropeltes*	Usually associated with deep water bodies. Found in large streams and canals with standing or slowly flowing water.	Carnivore. Preys mainly on fish but also feeds on some crustaceans.	Utilized as a food fish	The establishment of this fish in natural waters is unknown but if release in open waters may become a threat to the native population.
5. Arapaima *Arapaima gigas*	Often referred to as the largest freshwater fish. Its present culture condition is in ponds and tanks, No report on its occurrence in natural waters bodies.	Carnivore. Builds a nest of about 15 cm depth and 50 cm width in sandy bottoms. Spawns in April and May and guards the eggs and the young. Obligate air breather.	Expensive ornamental fish	Threat to native population
6. Red-bellied pacu *Piaractus brachypomus*	Reproduced in freshwater ponds using artificial spawning.	Feed mainly on aquatic plants and detritus. Has been proven to predate on small sizes of golden apple snail	Commercial culture in ponds as ornamental fish. It is a food fish in South America	Its ability to predate on small mollusks such as the golden apple snail is an indication that the fish can be explored as a biological control for the GAS and this may also be threat to other native mollusks.

Table 2. Continued

Common name and Zoological name	Environmental occurrence/distribution	Feeding ecology	Benefits	Potential invasive impact
7. White shrimp *Litopeneaus vannamei*	Found in brackishwater ponds	Detritivore	Commercial aquaculture species for food	Competitor of tiger shrimp *Peneaus monodon* Feared to become a Source of disease-causing pathogens that might affect the tiger shrimp *Penaeus monodon*
8. Australian redclaw *Cherax quadricarinatus*	Found in freshwater aquaculture ponds	Omnivore	Commercial aquaculture species for food	Competitor of the native shrimps Its burrowing behavior may be detrimental to dikes of fishponds and ricefields
9. Louisiana crayfish *Procambarus clarkii*	Since this species is introduced through the aquarium ornamental fish trade, the present occurrence of this may be in controlled aquarium condition. Occurrence in natural waters unknown.	Herbivore	Food and ornamental species	Potential pest of rice plants Competitor of native shrimps

*****Personal communication: Dr. A. G. Cagauan, Freshwater Aquaculture Center, CLSU, Philippines(unpublished).

Table 3. Invasive insect pest species in Philippine rice ecosystems.*

Stenchaetothrips biformis (Bagnall)
Atherigona oryzae (Malloch)
Locusta migratoria manilensis (Meyen)
Valanga nigricornis (Burmeister)
Nilaparvata lugens (Stal)
Sogatella furcifera (Horvath)
Nephotettix virescens (Distant)
Scirpophaga innotata (Walker)
Leptocorisa oratorius (F.)
Scotinophara coarctata (F.)
Scotinophara latiuscula Breddin
Scotinophara sp.

***** Personal communication: Dr. A.T. Barrion, PhilRice, Philippines (Unpublished).