PERFORMANCE AUDIT REPORT OF THE AUDITOR GENERAL

ON

THE ETHIOPIAN BIODIVERSITY INSTITUTE'S ACTION ON THE MANAGEMENT OF INVASIVE ALIEN WEED KNOWN AS WATER HYACINTH (Eichhornia Crassipses)

FEBRUARY, 2019
ADDIS ABABA, ETHIOPIA

Foreword by the Auditor General

I am pleased to publish and publicize this performance audit report that examines the Ethiopian Bio-diversity Institute's action on the prevention, detection, control and mitigation efforts on the dangerous invasive alien weed known as water hyacinth (Eichhornia Crassipses) which is affecting major lakes and rivers of our country.

My office carried out the audit under a proclamation to re-establish the Office of the Federal Auditor General (Proclamation No. 982/2016). In part two, article 5, sub article (3) of this proclamation mandates me to conduct performance audit on federal government offices and organizations.

This performance audit was conducted in accordance with the International Standards of Supreme Audit Institutions (ISSAIs) and based on my office performance audit manual.

This performance audit report was tabled to the House of Peoples Representative (the Ethiopian parliament), in accordance with proclamation No. 982/2016. I have also provided the copy of this report to the audited entity (the Ethiopian Biodiversity Institute) and to the Prime Minister Office.

Accordingly, the audited entity, the Ethiopian Biodiversity Institute has accepted all the findings of this performance audit report, and has sent an action plan to my office and to the Public Accounts Committee of the Ethiopian parliament, confirming its commitment to address the audit findings and recommendations.

Gemechu Dubiso

Auditor General

February 22, 2019

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LIST OF ACRONYMS/ABBREVIATIONS

AEZ	Agro Ecological Zone
BSE	Biological Society of Ethiopia
BOWR	Bureau of Water Resources
BOARD	Bureau of Agricultural and Rural Development
BOT&C	Bureau of Tourism and Culture
CSE	Conservation Strategy of Ethiopia
CBD	Convention on Biological Diversity
EDRR	Early Detection and Rapid Response
ECE	Environment Council of Ethiopia
EIA	Environmental Impact Assessment
EIAP	Environmental Impact Assessment Proclamation
EPE	Environmental Policy of Ethiopia
EPA	Environmental Protection Authority
EWSS	Ethiopian Weed Science Society
FIASC	Federal Invasive Alien Species Council
FRCP	Forest Resources Conservation Proclamation
FRS	Forestry Research Strategy
FSoE	Forestry Society of Ethiopia
GMO	Genetically Modified Organisms
GEF	Global Environment Facility
GISP	Global Invasive Species Programme
HLI	Higher Learning Institutions
EBI	Ethiopian Biodiversity Institute
IBC	Institute of Biodiversity Conservation
IBCR	Institute of Biodiversity Conservation and Research
IPPC	International Plant Protection Convention
IAS	Invasive Alien Species
MOARD	Ministry of Agriculture and Rural Development
MOTC	Ministry of Tourism and Culture
MOWR	Ministry of Water Resources
NBSAP	National Biodiversity Strategy and Action Plan
NBPS	National Biotechnology Policy and Strategy
NIAS SF	National Invasive Alien Species Stakeholders Forum
NPPO	National Plant Protection Organization

NGO	Non-Governmental Organization
OOARD	Office of Agriculture and Rural Development
PAP	Pathway Action Plans
REPA	Regional Environmental Protection Agencies
RIAR	Regional Institutes of Agricultural Research
RBIPMA	Removing of Barriers to Invasive Plant Management in Africa
WRMP	Water Resources Management Policy
WSRS	Weed Science Research Strategy

GLOSSARY OF TERMS

Alien species – non-native, non-indigenous, foreign, exotic species occurring outside of their natural range

Biodiversity – the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems. Short for biological diversity.

Biological control - an environmentally sound and effective means of reducing or mitigating Invasive Alien Species effects through the use of natural enemies.

Bio-security threats- means those matters or activities which, individually or collectively, may constitute a biological risk to the ecological welfare or to the well-being of humans, animals or plants

Conservation of biodiversity - the management of human interactions with genes, species, and ecosystems to provide the maximum benefit to the present generation while maintaining their potential to meet the needs and aspirations of future generations; encompasses elements of saving, studying, and using biodiversity.

Ecological restoration - an intentional activity that initiates or accelerates the recovery of an eco-system with respect to its health, integrity and sustainability. The practice of ecological restoration includes wide scope of projects including: erosion control, reforestation, removal of IAS and weeds, re-vegetation of disturbed areas, day lighting streams, reintroduction of native species, as well as habitat and range improvement for targeted species.

Ecosystem - a dynamic complex of plant, animal, fungal, and microorganism communities and their associated non- living environment interacting as an ecological unit.

Endemic species – a species restricted to a specified region or locality.

Exotic species- see Alien species.

Harmful species – plants and animals that sting, prickle, cause allergies, are poisonous to humans or other organisms or exclude other organisms from an ecosystem or habitat.

IAS prevention - prevention of introductions of IAS to national boundaries by intercepting several potential invaders linked to a single pathway.

Indigenous species - see **native species**

Intentional introduction – an introduction made deliberately by humans, involving the purposeful movement of a species outside of its natural range and dispersal potential. Such introductions may be done legally or illegally.

Introduction – the movement by humans of a species, subspecies or lower taxon outside its natural range. This movement can be either within a country or between countries.

Invasive alien species - alien species that become established in a new environment then proliferate and spread in ways that are destructive to native ecosystems, human health, and ultimately human welfare.

Manual control - removal that involves the use of tools such as shovels, axes, rakes, grubbing hoes, and hand clippers to expose, cut, and remove flowers, fruits, stems, leaves, and/or roots from target plants.

Mechanical control - is a method in a physical way, the invasive alien species can be removed by hands or machines. Removal that involves the use of motorized equipment such as mowers, "weed-whackers", and tractor-mounted plows, disks, and sweepers. Burning is also categorized here.

Native species– A species occurring within its natural range and dispersal potential, i.e. within the range it occupies naturally or could occupy without direct or indirect introduction or by care of humans.

Restoration - reintroduction of native species (see **Ecological restoration)**

Risk is a critical concept that is fundamental to responding to the challenge of invasive alien species. Even within the context of invasive alien species, there are many accepted definitions of risk and associated concepts in use, which vary across international agreements and, in turn, national policies and programs.

Risk analysis - can be considered as a systematic approach to decision making regarding the use of alien species through hazard identification, risk assessment, risk management, and risk communication.

Risk assessment - is defined as the "evaluation of the probability of the introduction and spread of a pest and of the associated potential economic consequences", where economic consequences are interpreted to include environmental consequences.

Risk communication - is defined as "… the interactive exchange of information on risk among risk assessors, risk managers and other interested parties".

Risk management - is defined as the "evaluation and selection of options to reduce the risk of introduction and spread of a pest".

Unintentional introduction – an unintended introduction made as a result of a species utilizing humans or human delivery systems as vectors for dispersal outside its natural range.

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EXECUTIVE SUMMARY

Background to the Audit

1. Water hyacinth (Eichhornia crassipses) has been ranked as one of the world's worst invasive alien weeds causing problems for millions of users of water resources. Water hyacinth has been identified by the International Union for Conservation of Nature (IUCN) as one of the 100 most aggressive invasive species and recognized as one of the top 10 worst weeds in the world). It is characterized by rapid growth rates, extensive dispersal capabilities, large and rapid reproductive output and broad environmental tolerance. Under favorable conditions, water hyacinths can double its mass every 5 days and it also grows from seed, which can remain viable for 20 years or longer.
2. Due to its high reproduction rate, the complex root structure and the formation of dense mats with up to two million plants per hectare, Water hyacinth *(Eichhornia crassipes)* has been causing an enormous problem in lakes, water reservoirs and irrigation canals. The introduction and spread of this alien weed threatens the environment, the economy and the society at large. This weed can have profound effects on biodiversity and ecosystem dynamics and services.
3. Although there is no precise evidence of when the Water Hyacinth was first observed in Ethiopia, yet, the extent of damage in the past decade was devastating. The existential threat posed by this aggressive and dangerous alien weed on the biodiversity, and lively hood of the citizens is very alarming. Significant number of farmers who are living near the infested lakes and rivers, and who are engaging in crop production, fishing and livestock have been seriously affected.
4. The Ethiopian Bio-diversity Institute, apart from other responsibilities is mandated to manage the Invasive Alien Species (IAS) under regulation No.291/2013. Moreover, the institute is also mandated by the same regulation to act as a focal point to biodiversity related international agreements to which Ethiopia is a party and cause their implementation in cooperation with regions and concerned bodies. .Since Ethiopia is a signatory Party to the Convention on Biological Diversity (CBD) should strengthen its efforts to effectively implement Article 8(h) of the CBD that calls on its parties to prevent the introduction of

invasive alien species, control or eradicate those alien species that threaten the ecosystems, habitats or species.

5. Accordingly, the objective of this audit is to determine whether the Ethiopian Bio-diversity Institute, actions are efficient and effective and associated accountability arrangements in place, in relation to the prevention, detection, control and mitigation efforts concerning the dangerous invasive alien weed known as Water Hyacinth(Eichhornia Crassipses), which is affecting the major lakes and rivers of Ethiopia.
6. The specific audit questions of this audit include: To what extent does the Institute Prevent Water Hyacinth infestation? To what extent does the Institute survey & explore distribution of water hyacinth to timely detect infestations of water hyacinth? Does the Institute develop an efficient, effective and economic control options and strategies that are applicable to eliminate water Hyacinth infestations? And finally, what is the restoration strategy of the Institute?
7. The audit covers the period from July 2010 to July 2018.The Ethiopian Bio-diversity Institute was the main audited institution. However, relevant data were collected from 27 main stakeholders such as public sector institutions, universities and regional offices. Moreover, the audit team collected relevant data from 5 lakes and 1major River. These are (Lake Tana, Lake Zewaye, lake koka, Lake Abaya, lake chamo and Nile River).

Summary of Findings

Development of a robust IAS risk assessment mechanism

8. The institute has never been established a robust IAS risk assessment mechanism. The institute has also failed to undertake the task of identification and management of one of the IAS, Water Hyacinth, Invasion vectors, sources and pathways to prevent or reduce spread in collaboration with the concerned bodies.
9. The Institute has failed to identify and manage water hyacinth Invasion vectors, sources and pathways, which are important factors for the prevention or reduction of the spread of the Water Hyacinth on the lakes and rivers of the country.
10. The institute and the relevant stakeholders have also failed to take measures which can focus on minimizing the risk of introduction presented by all existing pathways and vectors, including transportation of agricultural products (e.g. aid food), freight, secondhand vehicles,

import of planting material, trade in commodities and goods by post and courier services, aquaculture and movement of travelers by both air and land. Document reviewed in the institute also confirmed that, Ethiopia does not currently have the necessary capacity and proper mechanisms for preventing IAS introductions.

Awareness creation about the invasive alien weed, known as water hyacinth

11. Despite, some efforts; the institute has failed to conduct a well-organized, coordinated, and effective awareness creation, towards the prevention of invasive alien weed known as water hyacinth.
12. Similarly, interviews conducted with officials of key stakeholders such as the Ministry of Water, Irrigation, and Energy, 3 regional states (Amahara, Southern Nations and Oromia) biodiversity offices and 4 universities also confirmed that, the Institute has failed to coordinate and lead the public awareness creation, towards the prevention of the dangerous alien weed known as water hyacinth.
13. Moreover, Documents reviewed in the Ethiopian Biodiversity institute also confirmed that, IAS education and public awareness has never been systematic and it is spontaneous in its nature. Consequently the general public has been unaware of the consequence of certain behaviors that promoted the invasive alien weed, water hyacinth spread. The issue of IAS is not mainstreamed in the curricula of the education system in Ethiopia. Awareness of the general public is also limited, with some exception of experts working in a certain NGOs and government organizations in highly infested areas. The public in those areas also has basic information on the IAS.

Species specific survey

14. The issue of conducting species specific survey is mainly very important, when, the water body under invasive alien attack, is of a national significance, with regard to its richness of biodiversity, and its economic and social significance to the country. In this regard, Lake Tana is one of the most significant resources the country has. It is the largest lake in Ethiopia and the second largest in Africa. It holds 50% of the country's fresh water. It is also the source of the Blue Nile, which contributes up to 60% of the Nile's water. Not only is the lake important as a water source for over 123 million people in the Nile Basin, it is also a source

of livelihood of millions of farmers who are engaged in fishery, livestock and crop production around its basin.

15. Likewise, Lake Abaya, lake Chamo and Lake Koka are also important water bodies in terms of bio diversity and economic development to the country. These water bodies, however, have been seriously affected by the invasive alien weed water hyacinth, specifically in the past 6 to 7 years.
16. Given, the huge national, regional, and global significance of these water bodies, and the huge threat posed by this aggressive, and dangerous alien weed known as water hyacinth, the institute, needs to conduct a species specific survey as a matter of top priority. However, Interviews conducted with the concerned official of the Institute reveled that, the institute has not yet conducted a survey on the incidence and depth of Water Hyacinth infestation on the water bodies of the country. And the institute hasn't conducted any mapping on water hyacinth infestation and also didn't use any relevant technologies such as (digital aerial imagery, Satellite Hyper spectral mapping, and GPS cameras) to map the level and depth of Water Hyacinth infestation on the lakes and rivers of the country.
17. On the other hand, according to the interviews conducted with officials of the Amhara region environment, forestry, and wild life conservation authority, and the Southern nations region environment, forest, and wild life conservation authority, and officials of the Ethiopian Rift Valley Lakes Authority reveled that, they have been conducting the identification, and mapping of water hyacinth infestations on the water bodies of their respective regions, have been mainly, by using boats and GPS and also confirmed that they have never used technologies such as (digital aerial imagery, and Satellite Hyper spectral mapping in their effort to identify and map water hyacinth infestation in their region.
18. Documents reviewed from the Ethiopian Biodiversity Institute also confirmed that, early detection (ED) system was partially used in Ethiopia, mainly in pest prevention and control. An early detection and rapid response (RR) system is therefore at a rudimentary stage in Ethiopia.
19. Despite, the failure of the institute to conduct a species specific survey on water hyacinth infestation on the water bodies of the country, there have been few ad hock surveys conducted concerning the incidence and depth of water hyacinth infestation, in some of the lakes of the country.

20. The estimate of water hyacinth infestation coverage according to this survey is ca. 34 500 ha (3000 ha thick 2500 ha intermediate and 29000 ha scattered). All the 19 Kebeles in the five Woredas bordering Lake Tana. The assessment shows also that close to one-third or more than 30% of the shoreline (130 km distance) of the north-eastern part of the lake's shore is invaded by water hyacinth.

Rapid Response Mechanism

21. Despite, a serious threat posed by water hyacinth in major lakes and rivers of the country, the interviews conducted with officials of the institute reveled that, they have never developed and implemented eradication or containment plans for high priority outlier sites & never ensured rapid response plan to new incursions. Moreover, they have also failed to notify the public and make the resource available to deal effectively with the problem of water hyacinth infestation on major lakes and rivers of the country.
22. All the Interviewed officials from the concerned offices of, Amhara Regional State, Oromia Regional State, and the Southern Nations, Nationalities and Peoples' Regional State and two public universities, confirmed that, the Institute has never developed a national plan/program/ for the eradication of Water Hyacinth in areas where the infestation of Water Hyacinth have occurred. Moreover, the institute has also failed to develop a system for responding quickly to a new infestation of Water Hyacinth on water bodies in the country.
23. Interviews with concerned officials of the regions confirmed that despite the failure of the institute, they have prepared and implemented a rapid response action plan to control the problem of water hyacinth on the lakes and rivers of their regions. However, their efforts towards a rapid response action and their actions on the eradication and control of water hyacinth have been far from success.

Management Plan for Control Actions on Water Hyacinth Weed

24. Interviews conducted with officials of the Institute, revealed that, the Institute has never developed a management plan for implementing control actins on Water Hyacinth weed. And most of the Water Hyacinth infested water bodies in the country by and large have been managed by regional governments and community based groups.
25. According to the documents reviewed, the implementation of control actions on the water bodies have been fragmented efforts conducted since 2012. These efforts were mainly

focused on mobilizing affected farming communities to uproot and dispose the weed manually. Needless to say, these efforts were utterly ineffective in terms of controlling the spread of water hyacinth.

26. A series of mass mobilizations was organized, some by regional government authorities, others by civic society and volunteer groups, to dispose the weed using manual labor.

Assessment on the negative impact of Water Hyacinth Infestation

27. Interviews conducted with officials of the institute revealed that, the institute have never conducted any assessment concerning on the negative impact caused by the Water Hyacinth. However, interviews conducted with concerned regional officials and the findings from a few add hock researches conducted by some researchers in the universities reveled that, the impact of water Hyacinth is mainly observed in the biodiversity, fishing, livestock and crop production on the water bodies and their surrounding areas. These impacts include;

    - Interviews with Ethiopian Fish and Water Sciences Association indicated that, Water Hyacinth cover the surface of the lakes surrounding areas, this situation prevents enough sunlight and oxygen from entering the water, suppressing the algae(which is the main source of food for fishes) from accessing to sunlight, this prevents photosynthesis to occur as a result the growth of algae will be curtailed this situation lead to the loss of fish population in this regard particularly one of the most known fish tape in lake Tana known as Coroso, substantially decreased, in the past 6 to 7 years .

    - According to research document reviwed, Lake Tana has 28 species of fish, of which 21 are endemic. Commercially, the lake's most important fishes include the large African barbs, Nile tilapia and African catfish. The annual commercial value of fish production at Lake Tana is about USD$1.1 million. The potential fish production of the lake is estimated to be 13 000 tons yearly. But its current fish production is less than 1000 tons a year. Recent studies show a serious decline in fish stocks due to the spread of the aquatic weed water hyacinth around fish spawning grounds.

- Due to expansion of water hyacinth and its competition with the native species the submerging grasses and other native species becomes devastated. These affect a lot of cattle which are directly and indirectly dependent on the grass around the lake.
- During the field vist the audit team observed that, due to, Water Hyacinth spreads in the tropics of Lake Tana region (Dambia and Fogera Kebele), thousands of hectares of wet land, pasture and agricultural land have been ineffective.
- Interviews conducted with concerned officials of Oromiya Regional state reveled that, Water Hyacinth weed, invaded and destroyed variety of grass species grown on the shoreline of Koka Dam, and as a result the grazing land has been substantially reduced, creating a serious challenge, on the community, who are engaged in cattle breading. Similarly, due to, Water Hyacinth infestation on Lake Zeway, on the shoreline of the Lake caused, Animal and human drinking water shortages and the blocking of irrigation canals has also, resulted in water shortages.
- Research document reviewed, on the impact of water hyacinth on Lake Tana, revealed that, mat of water hyacinth during flooding and wave time makes rice production frustrating by totally covering the rice field. There was also one thing that most of the interviewed farmers gave strong emphasis that water hyacinth makes the farmland more compacted due to its long root that makes the farm land difficult to plough. The collected water hyacinth (heap) has noticeable impact on farm management because it took large place and makes the farmland fragile.
- Unlike the last five years, managing the farmlands for recession agriculture has become labor intensive due to infestation of this invasive weed. After the water shrinks, water hyacinth stay on the farm by penetrating its long root to the ground, therefore farmers clean their farmland for planting crop by family and employed laborers. Farmers spend a large amount of time and money for managing weeds when they prepare their farm land for recessional agriculture.

Restoration Plan for the Affected Biodiversity

28. Interviews conducted with concerned officials of the institute revealed that, the institute has never developed and implemented a restoration plan on the Water Hyacinth affected

biodiversity areas. And it has never discussed the issue with key stake holders; mainly because, they are currently want to engage with the issue of controlling the infestation of water hyacinth in water bodies of the country.

29. Similarly, interviews with key stake holders also revealed that, their current priority engagement is to deal with controlling the infestation of water hyacinth on lakes and rivers of the country, until it reached to a properly managed stage.

Conclusion

30. Water Hyacinth has been identified by the International Union for Conservation of Nature (IUCN) as one of the top 10 worst weeds in the world. Although there is no precise evidence of when the Water Hyacinth was first observed in Ethiopia, yet, the extent of damage in the past decades was devastating. The Ethiopian Biodiversity Institute in cooperation with relevant stakeholders have a statutory responsibility to coordinate and execute the Invasive Alien Weeds management actions, such as prevention, eradication or containment, control and restoration. However, the audit conclude that the Institute has failed to efficiently and effectively manage the problem of Water Hyacinth in Ethiopia.

CHAPTER ONE

1. Background of the Audit

Introduction

1.1 Invasive alien species are becoming increasingly problematic in many African countries including Ethiopia. Invasive alien species (IAS) are harmful species introduced by human action outside their natural past or present distribution. The introduction and spread of IAS threatens the environment, the economy and the society at large. IAS can have profound effects on biodiversity and ecosystem dynamics and services.

1.2 IAS has been causing massive negative impact on the Ethiopian economy, particularly the agricultural sector, public health and the environment. Therefore, it was critical that the country formulates, puts into effect and ensures effective implementation of a holistic National Invasive alien species Strategy.

1.3 Accordingly, the National Invasive Alien Species Strategy and Action Plan of Ethiopia was introduced and implemented in 2012 to enable the country strategically respond to existing and potential new threats posed by invasive alien species. The Strategy proposes to respond to the invasive alien species challenge through prevention of invasions, early detection of and rapid response to new invaders; and implementation of holistic and integrated management strategies against established invaders.

1.4 The overall goal of the IAS strategy and action plan was to protect biodiversity, quality of life and economic interests of Ethiopia from the adverse impacts of invasive alien species through an effective coordination framework and strong sense of shared responsibility across key stakeholders at national, regional and local levels.

1.5 Several institutions at various administrative levels- national, sub-national and local- are involved in the various aspects of IAS prevention and management. Consequently, synergy and coordination among these institutions is extremely important.

1.6 Furthermore, Ethiopia as a signatory Party to the Convention on Biological Diversity (CBD) should strengthen its efforts to effectively implement Article 8(h) of the CBD that calls on its parties to prevent the introduction of invasive alien species, control or eradicate

those alien species that threaten the ecosystems, habitats or species.

1.7 One of the key institutions in this regard is the Ethiopian Biodiversity institute. The institute under regulation No.291/2013. Is responsible to act as a focal point to biodiversity related international agreements to which the country is a party and cause their implementation in cooperation with regions and concerned bodies. Moreover, the Ethiopian biodiversity institute is also mandated to Control and follow up the negative impacts of invasive alien species on the country.

1.8 At present Water hyacinth (Eichhornia crassipses) have been ranked as one of the world's worst invasive weeds causing problems for millions of users of water resources. Water Hyacinth has been identified by the International Union for Conservation of Nature (IUCN) as one of the 100 most aggressive invasive species and recognized as one of the top 10 worst weeds in the world). It is characterized by rapid growth rates, extensive dispersal capabilities, large and rapid reproductive output and broad environmental tolerance. With its disruptive impacts on aquatic ecosystems, agriculture, fisheries, transportation, living conditions and social structures, Water hyacinth is justifiably called the world's worst aquatic weed due to its ability to rapidly cover whole waterways.

1.9 Although there is no precise evidence of when the Water Hyacinth was first observed in Ethiopia, yet, the extent of damage in the past decade was devastating. It has been a serious challenge in almost all major rivers and lakes of the country.

Motivation for the Audit

1.10 The Auditor General authorized the audit after having considered the following factors:

1) One of the factors considered was relevance or materiality of the audit topic. The dangerous invasive alien weed, Water Hyacinth, in the past few years has been seriously affecting major lakes and rivers of the country. The rate of invasion and the damage caused by this dangerous alien weed has created a clear and present danger on the lively hood of millions of farmers, who are engaged in crop production, livestock and fishery. This dangerous weed has also posed a serious challenge on the countries development projects such as: irrigation, hydroelectric and tourism. Moreover, the biodiversity losses on the major lakes and rivers have

been very alarming. Thus, the magnitude of the problem created by water hyacinth weed, and the need for assessing the efficiency and effectiveness of the legally responsible entity, the Ethiopian Biodiversity Institute and other responsible stakeholder's actions, towards managing this dangerous alien weed is a matter of national importance.

In addition, there have been significant public outcries concerning the problems created by this dangerous alien weed, Water Hyacinth. There have been a number of self-motivated and voluntary public mobilization efforts within the country and the diaspora community, towards addressing the problems of this alien weed. The problem of Water Hyacinth has also got a wide public and private media coverage.

2) The second factor considered was auditability of the audit topic. The audit office has confirmed that, relevant data for the audit can be available and the relevant audit methods can also be applicable. The audit office has also secured the necessary resources (budget, transport and time) to properly conduct the audit. In addition, relevant audit skills and criteria's have been confirmed available to conduct this performance audit topic.
3) Lastly, the potential for adding value and promote change by conducting this audit topic has also been considered. The audit office through its own assessment has come to a conclusion, that, by conducting this performance audit topic, it is possible to identify the major performance gaps, or problems of the main audited entity, the Ethiopian Biodiversity Institute and other responsible stakeholders, actions, and inactions, towards, managing this dangerous alien weed, Water Hyacinth. The audit office, also believed that, by conducting this performance audit, it is also possible to give valuable recommendations that can add value, towards, managing properly the problem of Water Hyacinth weed in the country. Moreover, the audit office believed that, this performance audit can also contributes towards, promoting good governance, accountability and helps the audited institution and relevant stakeholders, to have an independent information, that can contribute for improved performance and better service to citizens.

CHAPTER TWO

2. Design of the Audit

Objective of the Audit

1.11 The objective of this audit is to determine whether the Ethiopian Bio-diversity Institute, actions are efficient and effective and associated accountability arrangements in place, in relation to the prevention, detection, control and mitigation efforts concerning the dangerous invasive alien weed known as Water Hyacinth (Eichhornia Crassipses), which is affecting the major lakes and rivers of Ethiopia.

Audit Questions

1.12 The audit work was designed using four audit questions that are mainly focusing on the prevention, Detection, Control/ Elimination and Mitigation actions taken by The Ethiopian Biodiversity Institute with regards to water Hyacinth Infestation. The specific audit questions of this audit include:

i. To what extent does the Institute Prevent Water Hyacinth infestation?

ii. To what extent does the Institute survey & explore distribution of water hyacinth to timely detect infestations of water hyacinth?

iii. Does the Institute develop an efficient, effective and economic control options and strategies that are applicable to eliminate water Hyacinth infestations? And finally,

iv. What is the restoration strategy of the Institute?

Scope of the Audit

1.13 The audit covers the period from July 2010 to July 2018.The Ethiopian Bio-diversity Institute was the main audited institution. However, relevant data were collected from 27 main stakeholders such as public sector institutions, universities and regional offices. Moreover, the audit team collected relevant data from 5 lakes and 1major River. These are (Lake Tana, Lake Zewaye, lake koka, Lake Abaya, lake chamo and Nile river).

Methodology of the Audit

1.14 The methods used to conduct the audit included document reviews, interviews and physical observation.

Audit (Assessment) Criteria

1.15 The audit criteria drawn from statutory mandate, National Invasive Alien Species Policy, Strategy and Action Plan for Ethiopia, Convention on Conservation of Biodiversity (CBD), Published researches concerning water hyacinth and best management practices. The auditee, Ethiopian Biodiversity Institute has also accepted the proposed audit criteria. Details on the audit criteria are provided in Appendix 1 of this report.

CHAPTER THREE

3. Description of the Audit Area

Statutory Mandate and Role of Ethiopian Biodiversity Institute

1.16 The Ethiopian Biodiversity Institute was established by the Council of Ministers Regulation No. 291/2013. Some of the major powers and duties are:

- Initiate policy and legal proposals on the conservation and sustainable utilization of the country's biodiversity and the associated community knowledge as well as the fair and equitable sharing of benefits arising from their utilization, and upon approval enforce and follow up their implementation;
- Control and follow up the negative impacts of invasive alien species on the country'
- act as a focal point to biodiversity related international agreements to which the country is a party and cause their implementation in cooperation with regions and concerned bodies;
- work in cooperation with the concerned federal and regional bodies with respect to the conservation and sustainable use of, and access and benefit sharing from, biodiversity resources and community knowledge;
- survey and explore the diversity and distribution of the country's plant, animal and microbial genetic resources, identify and characterize the components thereof and monitor, from time to time, their conservation and sustainable use status;
- undertake researches relevant to ensure the conservation and sustainable utilization of biodiversity and the sharing of benefits arising from their utilization, and monitor the impact of processes and category of activities that have or are likely to have adverse impact on biodiversity and devise the appropriate methods for their conservation and sustainable use·

- based on ecosystem approach, survey, explore and study key biodiversity hotspots in the country and conserve, or facilitate the conservation of, same in-situ;
- in order to build the capacity of the regions and stakeholders in biodiversity conservation and sustainable utilization and access and benefit sharing, develop and provide guidelines and manuals, give training and other technical supports and follow up their implementation;
- issue directive on, and give import permit for, the introduction of biodiversity specimen into the country;
- in collaboration with mass media, learning institutions and other stakeholders, carry out activities to raise awareness among the public on the conservation and sustainable use of biodiversity and access and benefit sharing;

1.17 According to regulation No.291/2013 the Ethiopian Biodiversity Institute concerning the invasive Alien Species (IAS) has a mandate to initiate policies', strategies and action plans and also responsible for their implementation. Accordingly, the Institute has developed the Ethiopian IAS strategy and action plan.

The Ethiopian Invasive Alien Species Strategy and Action Plan Vision, Goals and Specific Objectives

Vision

1.18 To protect biodiversity/environment, quality of life and economic interests of Ethiopia from the adverse impacts of invasive alien species through an effective coordination framework and strong sense of shared responsibility of all key stakeholders at national, regional and local levels.

Goal

1.19 The overarching goal of the Ethiopian National IAS Strategy and Action Plan is to minimize the risk posed and reduce the negative impacts caused by IAS in Ethiopia.

Specific objectives

- Improve overall clarity and coordination of responsibilities and functions among stakeholders and provide an effective decision-making framework and associated communications processes concerning control, mitigation and eradication of invasive alien species;
- Achieve increased awareness of invasive alien species issues and promote appropriate changes in behavior or attitudes throughout all relevant sectors;
- Reduce and where possible, prevent, the intentional and unintentional introduction of invasive species;
- Ensure that effective response capabilities are in place and resourced to prevent the establishment of new invasions where possible;
- Ensure that sustainable action to control established invasive alien species is adequately resourced, packaged and delivered in expedited manner;
- Make optimum use of available capacity and resources to improve detection and monitoring capabilities; and,
- Identify gaps and priority issues for further development (for example in relation to prevention, monitoring, control and legislation).
- To control internal movement of IAS through effective mechanism of internal quarantine system.

Ethiopian Biodiversity Institute Organizational Structure

1.20 The Institute under regulation No.291/2013 has a Director General appointed by the government, and he is a chief executive officer of the Institute. The director general is accountable to the Ministry of Agriculture. The Institute consists of two key processes (Directorates), namely: (1) Biodiversity Conservation and Sustainable Use, and (2) Genetic Resources Transfer and Regulation; and five support processes, namely: (1) Public Relations and Communication, (2) Finance, Procurement and Property Administration, (3) Audit, (4) Plan & Programme, and (5) Human Resources Development and Administration. The Conservation and Use Directorate has five case teams, namely: (1) Animal, (2) Forest, (3) Crop & Horticulture, (4) Microbial Genetic Resources; and (5) Gene bank and Laboratories case teams.

Ethiopian Biodiversity Institute Human Resource

1.21 Based on the approved organizational structure, the institute has 906 positions. Out of this only 616 or 68% positions are filled with manpower and the rest 290 or 32% is vacant position. Among the employees 433 or 70% are males whereas 187 or 30 % are females.

Ethiopian Biodiversity Institute Source of Finance

1.22 The source of finance of the Ethiopian Biodiversity Institute is the government treasury. The yearly approved budget and expenditures during the financial year 2016 to 2018 are presented bellows.

***Table 1**: The Ethiopian Biodiversity institute annual budget and expenditure*

Budget year	Recurrent Budget		Capital Budget	
	Approved Budget	**Expenditure**	**Approved Budget**	**Expenditure**
2016	50,023,779.97	48,204,656.80	-	-
2017	60,378,315.00	57,501,858.06	15,000,000.00	13,305,252.40
2018	74,596,598.06	48,307,668.38	15,000,000.00	-
Total	**184,998,693.03**	**154,014,183.24**	**30,000,000.00**	**13,305,252.40**

Source: The Ethiopian Biodiversity Institute

CHAPTER FOUR

4. Audit Findings

I. Prevention of invasive alien weeds

Development of a robust IAS risk assessment mechanism

1.23 The Institute should develop a robust IAS risk assessment mechanism, so as to identify the pathways that present the highest risks for entry of IAS into Ethiopia, and to undertake a horizon scanning function, and also to identify the highest impact species that are most likely to enter and establish themselves in Ethiopia. Moreover, the Institute should develop screening processes to evaluate invasiveness of plants which are intended for planting and are moving in trade and also to evaluate invasiveness of terrestrial and aquatic IAS moving in trade.

1.24 The interviews conducted with the responsible officials of the institute reviled that, the institute have never been established a robust IAS risk assessment mechanism. The institute has also failed to undertake the task of identification and management of one of the IAS, Water Hyacinth, Invasion vectors, sources and pathways to prevent or reduce spread in collaboration with the concerned bodies.

1.25 Similarly, interviews conducted with officials of major stakeholders such as the ministry of water, irrigation, and energy, 3 regional states (Amahara, southern nations and Oromia) biodiversity offices and 4 universities also confirmed that, the Institute has failed to identify and manage water hyacinth Invasion vectors, sources and pathways, which are an important factors for the prevention or reduction of the spread of the Water Hyacinth on the lakes and rivers of the country.

1.26 Moreover, the document reviewed from the institute confirmed that, the institute and the relevant stakeholders have also failed to take measures which can focus on minimizing the risk of introduction presented by all existing pathways and vectors, including transportation of agricultural products (e.g. aid food), freight, secondhand vehicles, import of planting material, trade in commodities and goods by post and courier services, aquaculture and movement of travelers by both air and land. Document reviewed in the

institute also confirmed that, Ethiopia does not currently have the necessary capacity and proper mechanisms for preventing IAS introductions.

1.27 Responsible officials of the institute explained the reason for failing to establish a robust IAS risk assessment mechanism is mainly, due to, the capacity and resource limitation, despite some efforts by the institution. Moreover, Ethiopia as a land locked country and consequently having a substantial long boundary that it shares with five countries, is especially vulnerable to cross border movement of IAS. In addition, Ethiopia's large and complex geographic setting, relatively large volume of food aid coming into the country in the past, and due to the prevailing weak institutional capacity and limited awareness at various levels, prevention of IAS introductions has been impossible or has been seriously constrained despite the fact that there has been quarantine system in place since 1971.

1.28 As a result of poor IAS risk assessment mechanism, the prevention of IAS including the dangerous alien weed, Water Hyacinth, have been a serious challenge, towards the protection of the countries biodiversity resources.

Awareness creation about the invasive alien weed, known as water hyacinth

1.29 The Ethiopian Biodiversity institute, in collaboration with key stake holders, should design and implement an awareness creation mechanism about invasive alien weed, water hyacinth. The institute should also consider a range of means for communicating with different groups of the society, including via representative bodies, websites, mass media, and posters at points of entry, information leaflets, and codes of practice, identification guides, public talks and face-to-face meetings.

1.30 Improved awareness and understanding of the issues surrounding the invasive alien weed, water hyacinth, is a key to ensure wider support for the relevant policies and programs, and for engaging the public in decision-making. The public could play several roles; including helping reduce the likelihood of introducing invasive alien species or the risk of facilitating their spread, and assisting with their detection and monitoring.

1.31 Interviews conducted with officials of the Institute, revealed that, despite, some efforts; the institute has failed to conduct a well-organized, coordinated, and effective awareness creation, towards the prevention of invasive alien weed known as water hyacinth.

1.32 Similarly, interviews conducted with officials of key stakeholders such as the Ministry of Water, Irrigation, and Energy, 3 regional states (Amahara, Southern Nations and Oromia) biodiversity offices and 4 universities also confirmed that, the Institute has failed to coordinate and lead the public awareness creation, towards the prevention of the dangerous alien weed known as water hyacinth.

1.33 Moreover, Documents reviewed in the Ethiopian Biodiversity institute also confirmed that, IAS education and public awareness has never been systematic and it is spontaneous in its nature. Consequently the general public has been unaware of the consequence of certain behaviors that promoted the invasive alien weed, water hyacinth spread. The issue of IAS is not mainstreamed in the curricula of the education system in Ethiopia. Awareness of the general public is also limited, with some exception of experts working in a certain NGOs and government organizations in highly infested areas. The public in those areas also has basic information on the IAS.

1.34 The crisis, despite its catastrophic consequences, did not enter public consciousness until very recently. Credit must be given to the Amhara Mass Media Agency for bringing the issue to a wider audience. They have broadcasted a series of news reports, interviews, and documentaries about the invasion of the lake by water hyacinth. These programs have been crucial in informing the public about the scale of the problem.

1.35 As awareness grows, people soon start to talk about water hyacinth and Lake Tana. Environmental activists, civic society groups, singers, poets, writers, and ordinary citizens alike have all expressed their concern about the precarious condition of the lake. The issue has garnered substantial coverage both on mainstream and social media. This growing activism seemed to have registered with the government, especially at the regional level, as efforts to remove the weed have gained traction in recent weeks. A series of mass mobilizations was organized, some by government authorities, others by civic society and volunteer groups, to dispose the weed using manual labor.

1.36 Officials of the Institute explained, the cause of poor performance regarding awareness creation, is due to weak institutional capacity and resource limitation.

1.37 Due to the absence of a well-organized, coordinated and effective awareness creation effort by the Institute and responsible stakeholders, has created the majority of the population unaware of the problem of Water Hyacinth weed. It also curtails the probable participation of the public towards an efficient and effective prevention approach.

II. Early Detection and Rapid Response (EDRR)

1.38 ED and RR involve inventory and mapping of species, a rapid-response plan, public notification and making the resources available to act quickly when a new invader is discovered.

Species specific survey

1.39 The Institute in collaboration with key stakeholders should conduct species specific survey on the Invasive Alien Weed known as Water Hyacinth, infestation on the lakes and rivers of the country, In addition, the Institute should also apply relevant technologies such as (digital aerial imagery, Satellite Hyper spectral mapping, and GPS cameras) to map the level and depth of Water Hyacinth infestation on the lakes and rivers of the country.

1.40 Where specific threats are identified and prioritized, it will be appropriate to make regular surveys that are carefully planned using specific methods in potential habitats of possible invaders. The methods are very specific and will need to be designed, adapted or developed for each situation. Frequency and timing of surveys is important.

1.41 The issue of conducting species specific survey is mainly very important, when, the water body under invasive alien attack, is of a national significance, with regard to its richness of biodiversity, and its economic and social significance to the country. In this regard, Lake Tana is one of the most significant resources the country has. It is the largest lake in Ethiopia and the second largest in Africa. It holds 50% of the country's fresh water. It is also the source of the Blue Nile, which contributes up to 60% of the Nile's water. Not only is the lake important as a water source for over 123 million people in the Nile Basin, it is also a source of livelihood of millions of farmers who are engaged in fishery, livestock and crop production around its basin. In recognition of the lake's rich biodiversity and

significant cultural heritage, UNESCO added the lake to its World Network of Biosphere Reserves in June 2015. Moreover, the lake occupies an important place in the country's plan for economic development. The water from the lake is utilized for hydropower generation and supports large-scale irrigation schemes in the lowland agricultural areas. The lake, thus, is at the nexus of a complex web of political, economic and socio-cultural interests. Likewise, Lake Abaya, lake Chamo and Lake Koka are also important water bodies in terms of bio diversity and economic development to the country. These water bodies, however, have been seriously affected by the invasive alien weed water hyacinth, specifically in the past 6 to 7 years.

1.42 Given, the huge national, regional, and global significance of these water bodies, and the huge threat posed by this aggressive, and dangerous alien weed known as water hyacinth, the institute, needs to conduct a species specific survey as a matter of top priority. However, Interviews conducted with the concerned official of the Institute reveled that, the institute has not yet conducted a survey on the incidence and depth of Water Hyacinth infestation on the water bodies of the country. And the institute hasn't conducted any mapping on water hyacinth infestation and also didn't use any relevant technologies such as (digital aerial imagery, Satellite Hyper spectral mapping, and GPS cameras) to map the level and depth of Water Hyacinth infestation on the lakes and rivers of the country.

1.43 On the other hand, according to the interviews conducted with officials of the Amahara region environment, forestry, and wild life conservation authority, and the Southern nations region environment, forest, and wild life conservation authority, and officials of the Ethiopian rift valley lakes authority reveled that, they have been conducting the identification, and mapping of water hyacinth infestations on the water bodies of their respective regions, have been mainly, by using boats and GPS and also confirmed that they have never used technologies such as (digital aerial imagery, and Satellite Hyper spectral mapping in their effort to identify and map water hyacinth infestation in their region.

1.44 Documents reviewed from the Ethiopian Biodiversity Institute also confirmed that, early detection (ED) system was partially used in Ethiopia, mainly in pest prevention and

control. An early detection and rapid response (RR) system is therefore at a rudimentary stage in Ethiopia.

1.45 Despite, the failure of the institute to conduct a species specific survey on water hyacinth infestation on the water bodies of the country, there have been few ad hock surveys conducted concerning the incidence and depth of water hyacinth infestation, in some of the lakes of the country. One such case in point is the survey conducted by the initiation of Amhara Regional state with cooperation from different regional offices on the problem of water hyacinth infestation in Lake Tana. The Regional Technical Team (established from BDU, ORDA, BoEPLAU and ARARI) has made field surveys, to map the water hyacinth coverage on Lake Tana, from May 15, 2015 to May 25, 2015. The survey covered from Bahir Dar to Gorgora areas of Lake Tana, following the eastern and northern shores of the lake, using boat, which is the infested shore of the lake. The survey identified 19 infested Kebeles stretching across five Woredas (Dera, Fogera, Libo Kemkem, Gonder Zuria and Dembiya) infested with water hyacinth.

1.46 The estimate of water hyacinth infestation coverage according to this survey is ca. 34 500 ha (3000 ha thick 2500 ha intermediate and 29000 ha scattered). All the 19 Kebeles in the five Woredas bordering Lake Tana (Fig. 2) The assessment shows also that close to one-third or more than 30% of the shoreline (130 km distance) of the north-eastern part of the lake's shore is invaded by water hyacinth.

1.47 Similarly, according to a survey documents reviewed, water hyacinth was first observed on Lake Tana at Chera kebele of Dembya woreda around 2011/2012. By 2015, a significant swath of the lake’s northern and northeastern shores could be seen covered by water hyacinth. Estimates suggest that the weed during the time of survey covers 25,000 hectares of the lake. Recent media reports suggest that the weed is spotted on the mouth of Blue River as far as the edges of the Tis Issat Falls, demonstrating the weed’s capacity to expand itself to new areas.

1.48 Moreover, according to another survey, conducted by Solomon Kibret (PhD) and Abeyou Worqlul (PhD) on lake Tana , For the last 6-7 years, water hyacinth has been colonizing Lake Tana, the largest lake in Ethiopia. In 2011, it was noticed at the mouth of Megech River at the northeastern corner of the lake. Since then it has been expanding largely on the

northeastern corner covering the eastern and northeastern shorelines of the lake. Currently, the weed has invaded about 84 km length of the shoreline from Gorgora to Tana Qirqos. The pace of weed removal has been far slower than the rate of weed expansion. Bahir Dar, the seat for the Amhara Regional Government, is still immune from the infestation – thanks to a peninsula at Tana Qirgos that holds back the weed from its southward expansion – but will it remain so in the future? Remote sensing data (high resolution satellite images) indicates that the weed is progressing at an alarming rate southwards (Figure 1). If control measures are not taken timely, the weed may invade the shores of Bahir Dar in early next year. Monthly satellite data indicates a wild expansion of the weed between August and October 2018 following the wet season – reaching a record high in October 2018 (Fig 2).

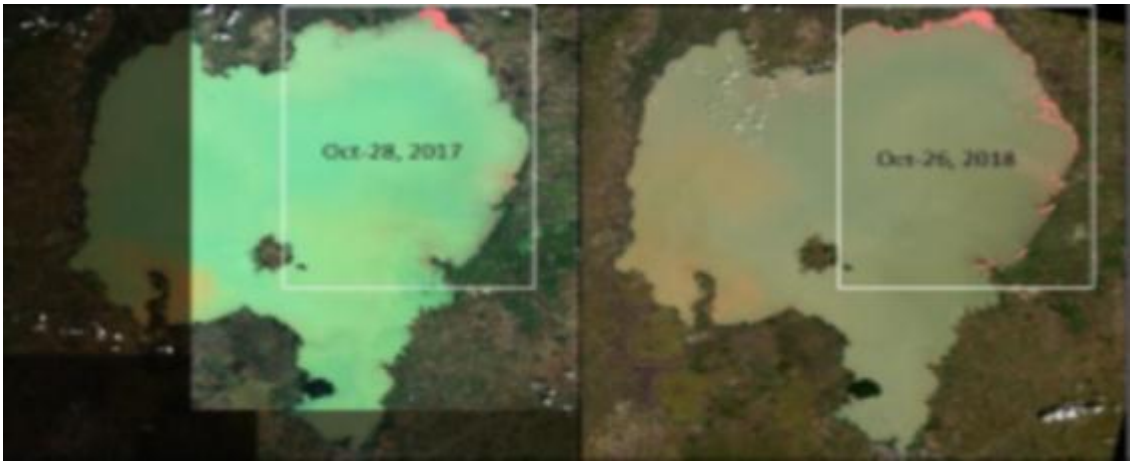

Figure 1: Satellite images showing water hyacinth distribution in October 2017 vs 2018.

Figure 2: Monthly trend of water hyacinth coverage around Lake Tana between August 2017 and October 2018 using remote sensing data. [Note: satellite data has uncertainties in quantification of the actual weed coverage. So data should only be used to see temporal trend – not to quantify the weed coverage

1.49 According to the interview conducted with officials of the institute, the reason or the cause for why the institute didn't conduct, a species specific survey on the invasive alien weeds water hyacinth, was due to the fact that these surveys have been conducted by different groups within the regions; as a result they prefer to focus on other issues. On the other hand according to the interviews conducted with key stake holders, they stressed the fact that, the institute has failed its legal responsibilities to coordinate the responsible stakeholders, towards conducting species specific survey on the threats posed by water hyacinth infestation the water bodies of the country.

1.50 The failure of the institute to conduct species specific survey, on water hyacinth, in cooperation with key stake holders, and the failure to map this weed creates a situation, where by the possibility of addressing the problem through understanding the nature of this alien weed and devising a proper strategy for a rapid response have been missed. As a result the problem of water hyacinth have been left to local remedies, creating un coordinated, fragmented and futile efforts, with very little national attention, until the management of this invasive alien weed became a serious challenge to the country.

Rapid Response Mechanism

1.51 The Institute in cooperation with key stakeholders, should develop and implement eradication or containment plans for high priority outlier sites & ensure rapid response plan to new incursions, notify the public and make the resource available to deal effectively with the problem of water hyacinth infestation on major lakes and rivers of the country.

1.52 The guiding principle is that given a host of evidence suggesting that an invasive alien species is having a substantial negative impact in many countries, eradication or control measures should be initiated as a matter of urgency. However, those measures shall be technically and financially feasible, environmentally safe and socially acceptable.

1.53 Whilst the government and concerned agencies should focus in particular on prevention measures, early intervention action and large-scale or national programs; empowering and supporting farmers to minimize the impacts on their land through provision of advice and practical information will also be important.

1.54 Despite, a serious threat posed by water hyacinth in major lakes and rivers of the country, the interviews conducted with officials of the institute reveled that, they have never

developed and implemented eradication or containment plans for high priority outlier sites & never ensured rapid response plan to new incursions. Moreover, they have also failed to notify the public and make the resource available to deal effectively with the problem of water hyacinth infestation on major lakes and rivers of the country.

1.55 All the Interviewed officials from the concerned offices of, Amhara Regional State, Oromia Regional State, and the Southern Nations, Nationalities and Peoples' Regional State and two public universities, as listed in Annex 2 confirmed that, the Institute has never developed a national plan/program/ for the eradication of Water Hyacinth in areas where the infestation of Water Hyacinth have occurred. Moreover, the institute has also failed to develop a system for responding quickly to a new infestation of Water Hyacinth on water bodies in the country.

1.56 Interviews with concerned officials of the regions confirmed that despite the failure of the institute, they have prepared and implemented a rapid response action plan to control the problem of water hyacinth on the lakes and rivers of their regions. However, their efforts towards a rapid response action and their actions on the eradication and control of water hyacinth have been far from success. The problems faced by the responsible regional administrations are presented as follows;

1.57 According to the interviews conducted with officials of the institute, they have acknowledged, their failure to respond as quickly as possible by developing and implementing eradication or containment plans for high priority outlier sites & ensuring rapid response plan practical action to new incursions of water hyacinth infestations in the country. They have also confirmed that, currently they are working with key stakeholders to deal with the issue in a coordinated manner.

1.58 Due to the failure of the institute to develop and implement eradication or containment plan for water hyacinth infestation in the water bodies of the country, the problem of water hyacinth reached to a point where eradication or containment became impossible to achieve.

III. Control options & Strategies

Management Plan for Control Actions on Water Hyacinth Weed

1.59 The Institute in cooperation with key stakeholders should develop a management plan for implementing control actins on Water Hyacinth weed. The Institute should also, coordinate and follow up its implementation.

1.60 Control should involve the wider stakeholders including individual farmers, private developers, federal, regional and local government actors, and those actors operating at field level, including the military, school, construction workers, and artisanal miners.

1.61 The focus of control action is often very site-specific but it is important that knowledge of best practice is shared, and that control is supported with strong evidence and information base

1.62 Interviews conducted with officials of the Institute, revealed that, the Institute has never developed a management plan for implementing control actins on Water Hyacinth weed. And most of the Water Hyacinth infested water bodies in the country by and large have been managed by regional governments and community based groups.

1.63 According to the documents reviewed, the implementation of control actions on the water bodies have been fragmented efforts conducted since 2012. These efforts were mainly focused on mobilizing affected farming communities to uproot and dispose the weed manually. Needless to say, these efforts were utterly ineffective in terms of controlling the spread of water hyacinth.

1.64 A series of mass mobilizations was organized, some by regional government authorities, others by civic society and volunteer groups, to dispose the weed using manual labor.

Figure 3: A group of young men removing water hyacinth from Lake Tana

1.65 Besides these mass mobilization campaigns, three state universities located around lake Tana, namely Bahir Dar University, University of Gondar and Debre Tabor University, have been taking various initiatives to tackle the problem. Bahir Dar University is working in collaboration with a local engineering firm to build a customized mechanical harvester for removing the weed. Researchers at the university are breeding flies and studying the possibility of applying a biological control mechanism against the weed. The Geospatial center at the university is helping the effort by providing essential information about the growth and movement of the weed using reconnaissance survey and remote sensing techniques. University of Gondor, on its part, is building a mechanical harvester in house.

1.66 The regional government has recently formed a high-level steering and technical committee to follow up the issue. The Environment, Forest and Wildlife Protection and Development Authority of the Amhara Regional State seems to be the main body tasked with coordinating the ongoing mass mobilization of the public to remove water hyacinth using manual labor.

1.67 Conspicuously absent from the picture are the various federal level agencies working on water and environment related issues, such as the Biodiversity Institute, Ministry of Environment, Forest and Climate Change, Ministry of Water, Irrigation and Electricity,

and Minister of Agriculture**.** Although these government institutions are, in one way or another, involved in the sustainable management and utilization of the country' s natural resources, their silence while the largest lake in the country is mired in a grave environmental crisis raises questions. Their inaction casts doubt on the commitment of the federal government to rescue the lake.

1.68 But, in order to reduce the weed infestation on Lake Tana, the Amhara Regional State Environment, Forest and Wildlife Conservation Authority, Bahir Dar and Gondar University voluntarily used various eradication techniques, including:

- The Amhara Regional State Environment, Forest and Wildlife Conservation Authority have been working on a massive mobilization effort coordinating the community through the districts physical eradication of Water Hyacinth on Lake Tana.
- Also the Amaga Private Limited Company has purchased a Water Hyacinth harvesting machine for $ 52,000 and donated to Amhara Regional State Environment, Forest and Wildlife Conservation Authority. This harvesting machine was removing Water Hyacinth from Lake Tana for a limited time. However, during field verification, the machine has failed to remove the weed as a result of breakage of the machine, mainly due to; the capacity of the machine was insufficient to harvest the weed in muddy and clay ground. The audit team witnessed the verification of the machine during a field visit at Lake Tana, at a site where the infestation of the weed was serious. As a result has been out of operational since then.

Figure 4: Water Hyacinth harvesting machine donated by Amaga p.l.c. after a few hours of operation, on lake Tana is out of service due to, capacity limitations, (Photos taken by the audit team during field visit on June, 2018)

- Another failed attempt to control water hyacinth in Lake Tana has been the effort made by Diaspora community of Ethiopians. Interviews conducted with Amhara regional state officials revealed that, the machine was donated to the Amhara Regional State Environment, Forest and Wildlife Conservation Authority by the International Tana Safety Association (A Diaspora community association). The association has purchased the machine from Canada, and sent it to Lake Tana for field trial. However, just like the machine donated by Amaga plc. this machine also failed during the field trial, mainly due to, the infestation rate of Water Hyacinth on Lake Tana is huge amount and very dense and the capacity of the machine was not compatible to the task required, as a result, the machine was incapable of harvesting the weed and stopped at Lake Tana without service since then. The audit team also confirmed the situation of the machine during filed visit.

Figure 5: Water Hyacinth harvesting machine donated by the International Tana Safety Association, a Diaspora Ethiopian community association have been out of service, since the first day of trial on Lake Tana. (Photos taken by the audit team during the field visit on Lake Tana, on June, 2018)

- Similarly, the other failed attempt, to control water hyacinth weed infestation on Lake Tana through machine harvesting have been the effort of one private company, Kake Textile PLC, who donated Excavator machine, to harvest water hyacinth weed on lake Tana. However, the attempt also failed due to similar factors, mentioned in the above efforts. But it was not possible to achieve the desired results.

- Furthermore, according to, the interviews conducted with officials of Amhara regional state, since the management and control of water hyacinth requires a huge resource, the Amhara Regional State, council has attempted to address the issue by establishing an institution for the purpose of mobilizing fund. Accordingly, the state governing council has approved the regulation for the establishment of Lake Tana Trust Fund, through this trust fund the regional state have managed to collect more than 30 million birr from various government and non-governmental organizations, private organizations and individuals. However, the resource mobilized has failed to properly address the problem, necessitating the full intervention of the Federal Government.

- In addition, Bahirdar University, apart from mobilizing the university community, students and staffs in the removal of the water hyacinth weed, on the Nile River, using manual or physical eradication technique, it has also attempted to develop

mechanical harvesting machine. Accordingly, the university, in cooperation with private company called, Mulat engineering private limited company, have been designing and in the process of developing a 19 million birr weed harvester machine. The audit team has observed the progress of the work during a filed visit at the university

Figure 6: The Bahir Dar University in cooperation with Mulat Engineering p.l.c. have been developing a Water Hyacinth harvesting Machine at a cost of 19 Million Birr (Photos taken by the audit team during a field visit at the university, on June, 2018)

- Gonder University in 2014, coordinated 384 communities at the university for the purpose of irradiating water Hyacinth infestation, through manual or physical method on Lake Tana, though it was not a success story. The university also, attempted to deal with the problem through developing a mechanical harvesting machine at a cost of 1.8 million birr, the machine was able to harvest the weed on the prototype test, however, after the main Water Hyacinth machine was completed, the machine failed to harvest the weed from Lake Tana. The audit team during the field visit at Gondar University and Gorgora port observed the harvesting machine sitting without operation.

Figure 7: Water Hyacinth harvesting machine developed by Gondar University at a cost of 1.8 million birr and stopped without service on Gorgora Port in Gonder. (Photos taken by the audit team during the field visit on June, 2018)

- Review of document revealed that, since no strategy has been devised to reduce or eliminate Water Hyacinth, the weed has rapidly eroded the entire ecosystem of Lake Tana, No strategy has been devised to reduce or eliminate weeds, except to attempt to remove Water Hyacinth by mobilizing the community and a removal technique that can keep pace with the rapid reproductive biology of Water Hyacinth could not be used.
- In addition, Bahir Dar University have been attempting a research on Biological method of water hyacinth control option, by replicating more than 150 weevils that feed Water Hyacinth in a laboratory that came from Wonji Sugar Plant.

Figure 8: Filed research on Weevils that feed Water Hyacinth in Bhair Dar University, Reproduction by Biological Method

- In addition, Gondar University in collaboration with the Ethiopian Forest Research Institute for Biological Control Mechanism of Water Hyacinth on Lake Tana in the experimental stage, are breeding fungi and the research has been developed from a laboratory to pond. Also Gonder University together with Wello University have been conducting chemical method of control on Water Hyacinth, though, the research have been at experimental stage.

Figure 9: Fungus pond test for control of Water Hyacinth by biological method at Gondar University

1.69 Because of the Institute has not developed and implemented a study-based control strategy in terms of the nature of the lakes and rivers to minimize or eradicate Water Hyacinth, the work being done in the regions where weed infestation occurred has not been able to prevent the spread of Water Hyacinth. Generally, ongoing efforts to control water hyacinth are incommensurate with the scale of the problem. They are marked by poor mobilization of resources and lack of coordination and decisive leadership. The inaction of federal agencies, which are better placed to deal with the problem both financially and technically, has exacerbated the problem.

IV. Restoration

Assessment on the negative impact of Water Hyacinth Infestation

1.70 The Institute in coordination with key stakeholders should conduct an assessment on the negative impact caused by the Water Hyacinth weed infestation on water bodies and surrounding areas.

1.71 Interviews conducted with officials of the institute revealed that, the institute have never conducted any assessment concerning on the negative impact caused by the Water

Hyacinth. However, interviews conducted with concerned regional officials and the findings from a few add hock researches conducted by some researchers in the universities reveled that, the impact of water Hyacinth is mainly observed in the biodiversity, fishing, livestock and crop production on the water bodies and their surrounding areas. These impacts include;

1. Effect of water hyacinth on fishing

1.72 Documents reviewed reveled that; Water hyacinth provides highly complex habitat structure by restricting the growth of other submersed macrophysics. This modification and habitat complexity at the surface of the water are likely affect fishes and other invertebrates. Water hyacinth can greatly affect fish catch rates because mats of water hyacinth can block access to fishing grounds clogging and damaging eye of net, and increasing costs (effort and materials) of fishing. Furthermore, water hyacinth tears gill nets and damage boats motor which accrue to cost of fishing.

1.73 Interviews with Ethiopian Fish and Water Sciences Association indicated that, Water Hyacinth cover the surface of the lakes surrounding areas, this situation prevents enough sunlight and oxygen from entering the water, suppressing the algae(which is the main source of food for fishes) from accessing to sunlight, this prevents photosynthesis to occur as a result the growth of algae will be curtailed this situation lead to the loss of fish population in this regard particularly one of the most known fish tape in lake Tana known as Coroso, substantially decreased, in the past 6 to 7 years .

1.74 According to research document reviwed, Lake Tana has 28 species of fish, of which 21 are endemic. Commercially, the lake's most important fishes include the large African barbs, Nile tilapia and African catfish. The annual commercial value of fish production at Lake Tana is about USD$1.1 million. The potential fish production of the lake is estimated to be 13 000 tons yearly. But its current fish production is less than 1000 tons a year. Recent studies show a serious decline in fish stocks due to the spread of the aquatic weed water hyacinth around fish spawning grounds.

1.75 Fishers invest extra time in detaching water hyacinth parts from gillnet after catching. Fishers put gillnet in non- infested area but when the wave starts the fishing gear becomes covered by water hyacinth, therefore the gill net is lost. Loss of gill net could result in

additional labor and fuel cost for finding their fishing gear and repair damaged gillnet. In the area of severe infestation, fishing is difficult especially around the shore area; this could strongly affect fishers that use artisanal fishing boat. Generally, the area infested by water hyacinth has reduces efficiency of fishing in the study area.

2. Effects of water hyacinth on livestock

1.76 According to reviewed research document, the study areas are known by potentially rich dairy cattle breeds known as Fogera breeds. The shore area of Lake Tana is rich in submersing grass (including hippo grass) which feeds lots of cattle for the surrounding inhabitants.

1.77 However, due to expansion of water hyacinth and its competition with the native species the submerging grasses and other native species becomes devastated. These affect a lot of cattle which are directly and indirectly dependent on the grass around the lake.

1.78 During the field vist the audit team observed that, due to, Water Hyacinth spreads in the tropics of Lake Tana region (Dambia and Fogera Kebele), thousands of hectares of wet land, pasture and agricultural land have been ineffective.

Figure 10: The impact of Water Hyacinth on on cattle grazing Land, near Lake Tana

1.79 Interviews conducted with concerned officials of Oromiya Regional state reveled that, Water Hyacinth weed, invaded and destroyed variety of grass species grown on the shoreline of Koka Dam, and as a result the grazing land has been substantially reduced, creating a serious challenge, on the community, who are engaged in cattle breading. Similarly, due to, Water Hyacinth infestation on Lake Zeway, on the shoreline of the Lake

caused, Animal and human drinking water shortages and the blocking of irrigation canals has also, resulted in water shortages.

3. Effect of water hyacinth on crop production

1.80 Research document reviewed, on the impact of water hyacinth on Lake Tana, revealed that, mat of water hyacinth during flooding and wave time makes rice production frustrating by totally covering the rice field. There was also one thing that most of the interviewed farmers gave strong emphasis that water hyacinth makes the farmland more compacted due to its long root that makes the farm land difficult to plough. The collected water hyacinth (heap) has noticeable impact on farm management because it took large place and makes the farmland fragile.

1.81 Unlike the last five years, managing the farmlands for recession agriculture has become labor intensive due to infestation of this invasive weed. After the water shrinks, water hyacinth stay on the farm by penetrating its long root to the ground, therefore farmers clean their farmland for planting crop by family and employed laborers. Farmers spend a large amount of time and money for managing weeds when they prepare their farm land for recessional agriculture.

Figure 11: Water Hyacinth on wetlands near Lake Tana

4. Effect of Water hyacinth on the ecosystem

1.82 Reviewed research documents revealed that, Water hyacinth invasions change the natural diversity and balance of ecological communities. These changes threaten the survival of

many plants and animals because the weeds compete with native plants for space, nutrients and sunlight. Water hyacinth also reduces biological diversity, impacts native submersed plants, alters immersed plant species by pushing away and devastating them, and also alter animal communities by blocking access to the water and/or eliminating plants the animals depend on for feed.

1.83 Water hyacinth has prominent effect on the environment by restricting the growth of other submersed and emergent macro-phytes and loss of native habitats. The weed also affects diversity, distribution and abundance of life in aquatic environments in the study area. In addition, water hyacinth leads to de-oxygenation of the water and enhances evapo-transpiration, thus affecting all aquatic organisms. Moreover, the death and decay of water hyacinth vegetation in large masses create anaerobic conditions and production of lethal gases. Generally, water hyacinth in combination with so many others anthropogenic activities (Asmare et al., 2016), is a severe problem for Lake Tana and the surroundings. Therefore, it needs immediate and appropriate measures before things become irreversible.

Restoration Plan for the Affected Biodiversity

1.84 The Institute in coordination with key stakeholders should develop and implement a restoration plan on the Water Hyacinth affected biodiversity areas.

1.85 Cumulative impacts of direct and indirect effects of invasive alien species can adversely affect habitat and ecological process. Therefore, rehabilitation of an area invaded by IAS involves restoring an ecosystem to its pre-invasion state or to a preferred status - wherever possible. Restoration actions for species, natural habitats and ecosystems that have been affected by IAS and recovery initiatives need to ensure that native and managed ecosystems are not re-invaded once invasive alien species are eradicated or controlled.

1.86 The first step to be done in the rehabilitation work is an assessment of the ecosystem's preferred future condition and restoration potential. This kind of assessment allows determining habitats with high rate of restoration success. It is important to recognize that any action taken should be cost-effective and proportionate to the level of threat, as well as taking in to account of any possible consequences for native species. It is very well established that when plant invasion expands it exerts its impact on species, ecosystems, people and the environment.

1.87 Interviews conducted with concerned officials of the institute revealed that, the institute has never developed and implemented a restoration plan on the Water Hyacinth affected biodiversity areas. And it has never discussed the issue with key stake holders; mainly because, they are currently want to engage with the issue of controlling the infestation of water hyacinth in water bodies of the country.

1.88 Similarly, interviews with key stake holders also revealed that, their current priority engagement is to deal with controlling the infestation of water hyacinth on lakes and rivers of the country, until it reached to a properly managed stage. A strong institutional setup is critically needed to coordinate, execute and monitor weed control efforts around Lakes. Management of weed control need to be coordinated which includes, planning control activities based on prioritizing areas with expanding weed; executing day-to-day activities by deploying well-trained experts that could supervise the work on the ground (i.e. operating harvesting machines, mobilizing the community for campaign, and following-up the implementation of control measures. It is after implementing these activities that the issue of restoration will come. Currently, the management of water hyacinth control is still at a lower stage.

CHAPTER FIVE

5. Conclusion

1.89 From the findings of the audit it has been concluded that:-

1.90 The Ethiopian Biodiversity Institute have failed to deliver its statutory mandate of establishing an efficient and effective prevention measures, which includes a robust risk assessment and public awareness creation mechanisms about IAS. As a result, the Institute and the relevant key stakeholders have failed to prevent the introduction of the most dangerous invasive alien weed known as Water Hyacinth, infestation on the major lakes and rivers of the country.

1.91 The failure of the institute to conduct a species specific survey on Water Hyacinth infestation and the failure to conduct mapping by using relevant technologies such as (digital aerial imagery, satellite hyper spectral mapping and GPS cameras) have seriously undermined the institutes and key stakeholders capabilities in understanding, the incidence, depth and distribution of the weed and for planning the possible alternative strategies and engagements to deal with the problem before it is too late.

1.92 The Ethiopian Biodiversity Institute has never developed and implemented eradication or containment plans for high priority outlier sites and has also failed to ensure rapid response to new incursions. Moreover, the Institute has also failed to notify the public and make the resource available. The Institute has been unable to apply a systematic effort to eradicate or contain the invasive alien weed known as Water Hyacinth while infestations are localized. As a result Water Hyacinth has gone out of control, reaching to a level where controlling the weed becomes a serious challenge to the country.

1.93 The institute has never attempted in developing a management plan for implementing control actions on Water Hyacinth infestation on water bodies of the country. As a result there have never been coordinated national actions towards controlling this weed. The management of control actions by and large has been left to the regional administrations, civic associations and universities. The control actions have never been research based. In most cases the control actions have been through mobilization of farmers to uproot and

dispose the weed manually, and a few attempts have also been tested through machine harvesting. Biological and chemical methods have not yet introduced. Generally the failure of the institute has created a fragmented and uncoordinated effort the attempt to control Water Hyacinth is far from successful.

1.94 The institute have never conducted any assessment concerning on the negative impact caused by Water Hyacinth infestation. In addition, it has also failed to develop and implement a restoration plan on the Water Hyacinth affected biodiversity area. As a result the extent of the impact caused by the invasion of the weed is not yet known. And the possibility of restoring any damage caused on the biodiversity has failed to be materialized.

CHAPTER SIX

6. Recommendation

1.95 Based on the audit findings and conclusions noted above, the following recommendations are provided:

The Institute in cooperation with key stakeholders need to:

- Develop a robust IAS risk assessment mechanism and Use the risk assessment process to identify the highest impact species that are most likely to enter and establish themselves
- Develop a process to identify high-priority invasive plants
- Improve and expand domestic risk analysis processes. Introduce new risk methodologies and scientific advances in understanding invasive species.
- Increase awareness of the importance of the 'preventative approach' in addressing the threats posed by invasive alien species;
- Promote better access to information about IAS – especially for sectors and interest groups involved in key pathways;
- Develop surveillance/monitoring schemes for known and potentially invasive alien species;
- Identify the highest priority known, and potentially, invasive alien species that should be subjected to the most intensive surveillance;
- Prepare protocols to evaluate and map invasive alien species risks.
- Prepare model guidance or plans that encourage rapid response contingency planning at the national and local level. Include planning for communications, response funding, cooperative mechanisms and other relevant issues.
- Agree, with key stakeholders, on a set of guiding principles for assessing and identifying what action or range of actions is feasible in terms of containment, control or eradication;
- Use risk analyses to identify priority invasive alien species and priority impacted habitats for control and management action at national and/or regional levels, including consideration of the feasibility of eradication programs;

- Assess the negative impacts of Water Hyacinth on the biodiversity
- Identify sites that have the highest ecological, social and/or economic values,
- Identify appropriate stakeholders and make collaboration on the use of native species for the restoration of degraded ecosystems,
- Promote natural restoration of degraded areas after eradication of IAS and work in the restoration of natural ecosystem,
- Organize restoration projects/programs at the regional, watershed or landscape level wherever appropriate,

1.96 Finally, we thank the Institute and the selected regional institutions and universities, the concerned executives and staff for providing the required information during the audit and for their timely cooperation with the audit interviews.

APPENDICES

APPENDIX-1: Assessment Criteria

NO	AUDIT ISSUE	ASSESSMENET CRITERIA
1.	**To what extent does the Institute Prevent Water Hyacinth infestation?**	1.1) The Institute should develop a robust IAS risk assessment mechanism, so as to identify the pathways that present the highest risks for entry of IAS into Ethiopia, and to undertake a horizon scanning function, and also to identify the highest impact species that are most likely to enter and establish themselves in Ethiopia. 1.2) The Institute should develop screening processes to evaluate invasiveness of plants which are intended for planting and are moving in trade and also to evaluate invasiveness of terrestrial and aquatic IAS moving in trade. 1.3) The Ethiopian Biodiversity institute, in collaboration with key stake holders, should design and implement an

		awareness creation mechanism about invasive alien weed, water hyacinth. 1.4) The institute should also consider a range of means for communicating with different groups of the society, including via representative bodies, websites, mass media, and posters at points of entry, information leaflets, and codes of practice, identification guides, public talks and face-to-face meetings.
2.	**To what extent does the Institute survey & explore distribution of water hyacinth to timely detect infestations of water hyacinth?**	2.1) The Institute in collaboration with key stakeholders should conduct species specific survey on the Invasive Alien Weed known as Water Hyacinth, infestation on the lakes and rivers of the country, 2.2) In addition, the Institute should also apply relevant technologies such as (digital aerial imagery, Satellite Hyper spectral mapping, and GPS cameras) to map the level and depth of Water Hyacinth infestation on the lakes and rivers of the

		country.
3.	**Does the Institute develop an efficient, effective and economic control options and strategies that are applicable to eliminate water Hyacinth infestations?**	3.1) The Institute in cooperation with key stakeholders should develop a management plan for implementing control actins on Water Hyacinth weed. 3.2) The Institute should also, coordinate and follow up its implementation.
4.	**What is the Restoration strategy of the Institute?**	4.1) The Institute in coordination with key stakeholders should conduct an assessment on the negative impact caused by the Water Hyacinth weed infestation on water bodies and surrounding areas. 4.2) The Institute in coordination with key stakeholders should develop and implement a restoration plan on the Water Hyacinth affected biodiversity areas.

APPENDIX-2: List of Regions, Universities and other Government offices interviewed and visited

NO.	List of Regions	List of Offices
1	**From the Amhara National Regional State**	1. The Amhara Regional State Environment, Forest and Wildlife Conservation Authority
		2. Ethiopian Biodiversity Institute, Bahir Dar Biodiversity Center
		3. Nile Basin Authority
		4. Bahir Dar University
		5. Gonder University
		6. Center for Agricultural Research in the Amhara Regional State, Bahir Dar Fish and Aquatic Research Center
		7. Bureau of Agriculture of Amhara Region
		8. Amhara Regional Water Resources Bureau
2	**From the Oromia National Regional State**	9. Zeway Fish and other Aquatic Life Research Center
		10. Oromia Region Environment, Forest and Climate Change Authority
		11. Adama University
		12. Arsi University

		13. Zeway City Administration Environmental Forest and Climate Change Authority
		14. Koka City Administration Office
		15. Koka Dam Power Generation Office
		16. Office of the Lome District Administration
3	**From the Southern Nations, Nationalities and Peoples' Regional State**	17. Ethiopian Biodiversity Institute, Hawasa Biodiversity Center
		18. South Region Water Resources Bureau
		19. Southern Region Environment and Forest Conservation and Authority
		20. Hawasa University
		21. Arba Minch University
		22. Ethiopian Rift Valley Lakes Basin Authority
		23. Arba Minch Vocational College
		24. Gamo Gofa Zone Environment and Forest Conservation Office
4	**From Addis, Ababa**	25. Environment, Forest and Climate Change Commission
		26. Ministry of Agriculture
		27. Ethiopian Fisheries and Aquatic Sciences Association