

CROCODILE MANAGEMENT IN ETHIOPIA

Review with Recommendations



A REPORT PRESENTED TO THE ETHIOPIAN WILDLIFE
CONSERVATION AUTHORITY ON BEHALF OF THE IUCN-SSC
CROCODILE SPECIALIST GROUP

By

MATTHEW H. SHIRLEY, LUDWIG SIEGE, AND

MESERET ADEMASU

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REVIEW TEAM CONTACT INFORMATION

Matthew H. Shirley, PhD

- Member, IUCN-SSC Crocodile Specialist Group (mshirley@ufl.edu)
- Director, Orata Consulting, LLC, 3709 SW 15th St, Gainesville, FL 32608, USA (orataconsulting@gmail.com)
- Manager of Concession Development, SFM Safari Gabon, B.P. 1107, Libreville, Gabon (mshirley@sfmafrica.com; +241 (0)4894572)

Ludwig Siege, PhD

- GIZ-IS, UNDP/GEF
- Ethiopian Wildlife Conservation Authority
- Project "Sustainable Development of the Protected Area System of Ethiopia" (SDPASE), P.O. Box 28127, Code 1000, Addis Ababa, Ethiopia (ludwig.siege@giz.de; ludwig.siege@gmail.com; +251 (0)913-073700)

Meseret Ademasu

- Senior Biologist, Parks and Tourism Development and Utilization Department, Southern Nations, Nationalities and People's Regional State (ademasumeseret@gmail.com)

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The Ethiopian Wildlife Conservation Authority (EWCA) delegation at CITES CoP15 requested the IUCN-SSC Crocodile Specialist Group to carry out a review mission to Ethiopia to examine their crocodile management efforts, which have included ranching and limited trophy hunting in the past. In Ethiopia, the review mission was greatly facilitated by Kumara Wakjira and Kahsay Gebre-Tensae of EWCA and Abraham Mariye, Warden of Nechsar National Park. We would like to thank Roman Kassahun and Fetene Hailu for answering our many questions, particularly about crocodile trade and utilization in Ethiopia. We thank Dr. Tigist Ashagere (Manager, Arba Minch Crocodile Ranch) for access to the AMCR facility and details of their operations. We thank Dr. Murali Pai (Arba Minch University) for encouraging the review and assisting with surveys. Christine Lippai, Charlie Manolis, and Grahame Webb reviewed a draft of the report. We particularly thank GIZ office manager Mahder Zeleke and driver Tesfaye Gebremeskel for the logistic and administrative support implicated in the success of the mission. Finally, this review would not have been possible without the encouragement and financial support from many people, including: Conservation Force, Dallas Safari Club, Ethiopian Rift Valley Safaris, EWCA, GIZ, IUCN-SSC Crocodile Specialist Group, Orata Consulting LLC, and Wildlife Management International Pty. Limited.

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LIST OF ABBREVIATIONS

| | |
|--------|--|
| AMCR | Arba Minch Crocodile Ranch |
| APF | African Parks Foundation |
| CHA | Controlled Hunting Area |
| CITES | Convention on International Trade in Endangered Species of Wild Fauna and Flora |
| CSG | Crocodile Specialist Group of the Species Survival Commission (SSC) of the International Union for Conservation of Nature (IUCN) |
| CoP | Conference of the Parties to CITES |
| EO | Eyes Only |
| ERVS | Ethiopian Rift Valley Safaris |
| EWCA | Ethiopian Wildlife Conservation Authority |
| HCC | Human-Crocodile Conflict |
| IUCN | International Union for Conservation of Nature |
| MA | CITES Management Authority |
| NDF | Non-Detriment Finding |
| SA | CITES Scientific Authority |
| SNNPRS | Southern Nations, Nationalities, and People's Regional State |
| SSC | Species Survival Commission of the IUCN |
| TL | Total length |
| Woreda | District |

EXECUTIVE SUMMARY

The IUCN-SSC Crocodile Specialist Group conducted a review mission to Ethiopia from 26 April – 08 May 2014 to examine Ethiopia's Nile crocodile (*Crocodylus niloticus*) conservation and management program and the status, and likely sustainability, of ranching and trophy hunting initiatives. The review involved considerable input about operations, and the legal and policy frameworks supporting those operations, from the Ethiopian Wildlife Conservation Authority (EWCA), the Southern Nations, Nationalities and People's Regional State (SNNPRS), and the Arba Minch Crocodile Ranch (AMCR). We visited the AMCR and conducted three day and night crocodile surveys of the Lake Chamo crocodile population. The Ethiopian authorities requested the CSG to make recommendations as appropriate, which we present herein.

The review mission team was impressed with the will and capacity of the Ethiopian institutions and staff to manage their Nile crocodile populations with sustainable utilization as a central platform. The ranching and trophy hunting programs were historically established with a solid understanding of the CITES legislative requirements, as well as the biological and social sustainability drivers of crocodile utilization. This foundation still exists, but various refinements are recommended to ensure the long-term sustainability of the program.

- 1) We consider the development of a formal *Ethiopian Nile Crocodile Management Plan* to provide a united operational framework for crocodile conservation and management a priority. Issues that need to be addressed in the process of deriving this plan include:
 - a. The biological and economic sustainability of both the ranching and trophy-hunting programs;
 - b. The implementation of a formal, preferably annual, population monitoring program;
 - c. Significant improvement of reporting internally and internationally;
 - d. A clear and transparent protocol for setting hatchling harvest quotas.
- 2) We identified several administrative and practical problems of compliance with CITES Article IV (non-detriment) and the specific requirements of the CITES "Ranching Resolution" [Resolution Conf. 11.16 (Rev. CoP15)].
- 3) EWCA activities with and trade of Nile crocodiles would be improved if a clear focal point for Nile crocodile issues is identified within the CITES Scientific Authority. Ideally this focal point will work collaboratively with SNNPRS.
- 4) The commercial viability of AMCR could be improved if a business plan were developed that fully integrates all potential aspects of the operation.

1. INTRODUCTION

1.1. Context

A ranching program for Nile crocodiles (*Crocodylus niloticus*) was implemented in Ethiopia in 1985 with the government establishment of the Arba Minch Crocodile Ranch (AMCR). Ethiopia's population of *C. niloticus* was listed on Appendix II under the ranching Resolution Conf. 3.15 [now Resolution Conf. 11.16 (Rev CoP15)] in 1992 and, within the program, provision for a limited number of crocodiles to be taken under a "sport-hunting license" was included. Prior to 1992, Ethiopia had a CITES-approved annual export quota of up to 20 Nile crocodile skins per year (1990 pursuant to Resolution Conf. 5.21). A review of global crocodilian ranching programs conducted by the IUCN-SSC Crocodile Specialist Group (CSG) for CITES in 2004 concluded for Ethiopia that: "there is little doubt that the current utilization through ranching and trophy hunting is sustainable" (Jenkins *et al.* 2006).

In early 2007, Whitaker (2007) carried out a consultancy for the African Parks Foundation (APF), an organization that was at that time managing two national parks in Ethiopia (Omo and Nechsar), and the Ethiopian Wildlife Conservation Authority (EWCA). The consultancy involved surveys of *C. niloticus* in Lake Chamo and the formulation of a management program for the "conservation and sustainable utilization of the Lake Chamo crocodile resource." The surveys confirmed that the crocodile population had increased following the cessation of widespread and unregulated hunting in the 1950s and 1960s, but suggested that it had only increased to around 17.5 – 25% of historical levels. The report highlighted fishing, grazing, and lakeside agriculture as the predominant contemporary threats to the crocodile population.

Although the consultants (R. Whitaker and N. Whitaker) were members of the CSG, the work undertaken was not carried out under the auspices of the CSG. EWCA erroneously assumed that it was and that the report (and its conclusions) represented formal recommendations from the CSG. As a consequence, they banned the limited trophy hunting on Lake Chamo in July 2007 despite the benefits trophy hunting had been providing to crocodile conservation and the Ethiopian government's adoption of a policy that, in principle, supports trophy hunting as a readily adaptive conservation tool.

At CITES CoP15 (Qatar, 2010), CSG representatives met with the Ethiopian delegation and discussed various issues facing the government-run AMCR, particularly skin quality and potential skin markets. At that time the CSG was unaware of the misunderstanding about its role in the Whitaker (2007) report. The CSG Chairman and other CSG members attending CITES CoP16 (Bangkok, 2013) met again with the Ethiopian delegation and clarified their ongoing support, in principle, for trophy hunting as a tool in incentive-driven conservation and their independence from the conclusions reached by Whitaker (2007) in the report to APN.

Discussions at CoP16 focused on three issues: the operation of the ranching program and AMCR; current levels of human-crocodile conflict (HCC); and, the possibility of a CSG review of crocodile conservation and management in Ethiopia. The 2014 quotas for *C.*

niloticus from Ethiopia published on the CITES website (<http://cites.org/sites/default/files/common/quotas/2014/ExportQuotas2014.pdf>) comprise 3000 ranched skins and 5 trophies. Thus, Ethiopia has the legislative foundation to improve its ranching operations and to re-open crocodile trophy hunting as per the declared quota on the CITES website.

It is within the context of these events and discussions that an official CSG review was requested by EWCA and, subsequently, implemented.

1.2. Objectives

- Objective 1:* Review crocodile conservation, management and ranching (including possible farming) in Ethiopia and provide recommendations as necessary.
- Objective 2:* Examine preliminarily the extent of human-crocodile conflict (HCC) and determine strategies that could be employed to improve public safety if necessary.
- Objective 3:* Evaluate the modest trophy hunting strategy approved by CITES and make recommendations on whether it should be continued and under what conditions.
- Objective 4:* Provide a summary report including recommendations on the conservation and management of the Ethiopian population of *C. niloticus* with particular focus on Lake Chamo (e.g., population status, management programs, monitoring, etc.), improvement of existing and future crocodile ranching infrastructures, crocodile trophy hunting, and compliance with CITES.

1.3. Members of the Review Team

- Matthew H. Shirley, PhD: Dr. Shirley is a crocodile biologist specializing in African crocodile conservation, management, ecology and evolution. He is currently Director of Concession Development for SFM Safari Gabon, where he works in collaboration with the Gabonese national parks agency to develop sustainable ecotourism in the national parks network. He is a member of the IUCN-SSC Crocodile Specialist Group since 2008.
- Ludwig Siege, PhD: Dr. Siege has been a staff member of the German Agency for Technical Cooperation (GTZ; now GIZ) since 1980. He implemented a number of German and European-funded conservation programs and was involved in crocodile management issues in Tanzania, Madagascar, and Ethiopia. Presently he is in charge of a protected area program in Ethiopia, funded by the Global Environment Facility (GEF). He is a member of the IUCN-SSC Crocodile Specialist Group since 2014.

- Meseret Ademasu: Mr. Ademasu is a biodiversity expert for the Southern Nations, Nationalities and People's Regional State (SNNPRS) Bureau of Culture and Tourism and the senior expert in the Tourism and Parks Development and Utilization Department.

2. FINDINGS AND RECOMMENDATIONS

Before detailing our findings and recommendations, we would like to stress that we were impressed by the Ethiopian crocodile management program and its exceeding potential to benefit both the Ethiopian economy and the crocodile population alike. In general, we found that the administrative will, personnel capacity, and existing ranching and trophy hunting infrastructures form a solid base from which the minor adjustments recommended here will ensure the long-term sustainability of utilization-based crocodile management in Ethiopia. The majority of the recommendations presented are designed to assist EWCA and the SNNPRS to ensure they are in full compliance with Ethiopia's obligations to CITES, and may only require minor commitment/effort to implement.

Each of the recommendations presented below is accompanied by some minor discussion/supporting information, but full details and a more extensive discussion are included in Section 3 of the report. We would also like to clarify that neither here nor in Section 3 did we repeat information discussed extensively in the Whitaker (2007) report and consider that to be a necessary companion to this report.

2.1. Develop an Integrative Ethiopian Crocodile Management Plan

The Nile crocodile is not listed as a protected species in Ethiopia and, because of this, consumptive use programs are permitted under Ethiopian legislation. The species is currently subject to both consumptive (e.g., ranching and trophy hunting) and non-consumptive (e.g., tourism) uses, as well as implicated in human wildlife conflict. Crocodiles are theoretically managed by federal, state, zonal, and woreda (district) administrations under national laws for biodiversity protection and utilization, ranching, and trophy hunting. While the legislation appears adequate to manage the species, the relative roles of the different authorities in implementing and taking responsibility for different management tasks (i.e., monitoring, quota setting, reporting, etc.) are not always clear.

A formal management plan that addresses “what” needs to be done and “who” is responsible for doing it would add clarity and define the roles and relationships of the federal and regional authorities in crocodile management (see recommendations below for additional information). A formal management plan should also provide a framework for overcoming some current management deficiencies: 1) setting the hatchling harvest quota for the ranching program; 2) ensuring national and international-level reporting obligations are met; and, 3) ensuring population and trade monitoring obligations are met. Finally, a management plan offers the opportunity to define exactly the strategies employed for annual population and harvest monitoring, managing trophy hunting, managing tourist interactions, responding to human-crocodile conflict, law enforcement, and community benefits from management.

2.2. Develop an Administrative Process to Clearly Document Non-Detriment

Nile crocodile utilization in Ethiopia was originally structured to meet the requirements of CITES Resolution Conf. 11.16 (Rev. CoP15) on Ranching (previously Resolution Conf. 3.15). This nominally requires Ethiopia to submit an annual report to CITES and, although the information required as part of annual reports has been reduced, the full

complement of information is still required to be maintained by the country and be available if requested by the CITES Secretariat.

The ranching resolution also requires continual demonstration of *conservation advantage*, which is arguably a stronger requirement than Article IV of the Convention (Regulation of Trade in Specimens of Species Included in Appendix II), which stipulates that exports are only permissible when *not detrimental* to the survival of that species. This is normally satisfied by survey data, specifically: “the status of the wild population concerned (be) established by monitoring at an appropriate frequency and with sufficient precision to allow recognition of changes in population size and structure owing to ranching.”

It is now well established (e.g., Jenkins *et al.* 2006) that ranching programs have limited impact on wild crocodile populations, and the review mission found no evidence suggesting that Ethiopia’s ranching program was detrimental or unsustainable. However, in failing to demonstrate non-detriment, Ethiopia is not complying with CITES, and this represents a risk to the program that could be easily avoided. Four areas for consideration are:

2.2.1. CITES Scientific Authority

EWCA, as the designated SA, does not have an administrative protocol in place within the SNNPRS to independently establish that the Nile crocodile ranching and trophy hunting programs are providing a conservation advantage and/or are non-detrimental to the survival of the Lake Chamo crocodile population, and this should be rectified.

In Ethiopia, the CITES Management Authority (MA) and the CITES Scientific Authority (SA) are both vested in the EWCA, which is an option available to Parties (e.g., Australia has the same situation). However, we found that there is no separate directorate within EWCA acting as an independent functional SA, as envisaged by CITES.

Article IV of the Convention defines the role of the designated SA in the trade of Appendix-II species, and it is the SA that needs to demonstrate that any recommended trade is non-detrimental. The SA is also charged with monitoring both the granted export permits and the actual exports. CITES does not specifically stipulate how the SA must do either and, thus, Parties are free to delegate or engage other relevant national or regional state authorities to provide these assurances. However, it remains the responsibility of the SA to quality control this process and collate the information for communication back to the Secretariat.

Article 14 of the Ethiopian *Development, Conservation, and Utilization of Wildlife Proclamation* relegates responsibility for wildlife ranching and management of hunting concessions to the regional states, though there is no specific stipulation as to how the regional authorities must interact with EWCA to ensure that ranching enterprises are non-detrimental. For example, the annual AMCR hatchling harvest quota does not appear to have any direct oversight by EWCA (e.g., via a national harvest permitting process). However, given that

crocodile ranching has demonstrated relatively low potential for long-term population detriment (e.g., Jenkins *et al.* 2006), this may not be problematic. That being said, having a designated SA, either within or outside EWCA, to independently assess CITES-related requirements is an important safeguard.

2.2.2. Record Keeping and Reporting

We found virtually no current record keeping for hatchling harvests, growth, mortality and skin sales, despite them being requirements of the Appendix-II listing, and this should be rectified.

Related to finding 2.2.1 is the current lack of record keeping and reporting on the crocodile utilization program at state, federal, or international (CITES) levels. We were provided with high quality data and reports on all aspects of the crocodile ranching enterprise (e.g., population monitoring, hatchling harvest, grow-out statistics, hatchling mortalities, skin sales, etc...) from the mid-1980's to the early 2000's. Biennial reports to the CITES Secretariat on the ranching operation, as required under Resolution Conf. 11.16 (Rev. CoP15), were only available for 2003/04, 2005/06 and 2007/08 (<http://www.cites.org/eng/cms/index.php/component/cp/country/ET/national-reports>); however, the information they contain on captive stocks, the status of wild population levels, and trophy hunting is scant. Data generation and record keeping are essential to establishing the sustainability of harvests over time – particularly standardized population and nest survey results, and harvest records. Improved record keeping will also be important to the development of a more viable business model for the AMCR.

2.2.3. Hatchling Harvest Quota Setting

We did not find any strategic approach to setting the annual hatchling harvest quota from Lake Chamo. That being said, a harvest 'ceiling' (i.e., a general maximum number of individuals) may be all that is needed in lieu of a rigid annual harvest quota if regular population and/or nest monitoring data are used to support annual decision-making within such a ceiling.

The annual hatchling harvest quota for Lake Chamo has been set at ± 3000 individuals per year since 2007, which is a conservative amount following the potential upper limit (e.g., 10,000) suggested by Whitaker (2007), and which matches the space and resource limitations at AMCR. While Whitaker (2007) may have provided reasonable estimates of annual reproductive output by the crocodiles, no mechanism for adjusting for changes in the population or reproductive output since 2007, or indeed for establishing the sustainability of harvests greater than 3000, were adopted by EWCA. Since 2007, the Lake Chamo landscape has changed considerably, but whether this negatively or positively impacts the crocodile population is unknown.

In addition, the annual hatchling harvest quota appears to not be rigid. For example, in 2010 approximately 6000 hatchlings were harvested to provide founder stock for the Blen Development PLC (private ranch in Arba Minch), and in 2012 over 3500 individuals were harvested for no other apparent reason

than limited logistical control at the time hatchlings are removed from the nesting beaches. Fortunately, in the absence of any significant harvest, or other off-take (i.e., net mortalities), of juveniles and adults, a maximum harvest of hatchlings may well be sustainable. That being said, population and/or nest surveys over time are needed to determine whether crocodile abundance generally, or of juveniles and adults specifically, increases, decreases, or remains stable while the harvest is being conducted.

We would encourage EWCA to consider instituting a national ranching permitting process in which SNNPRS would be required to request an annual hatchling harvest permit from EWCA. Ideally, the request would be supported by population monitoring data, as well as current ranch statistics (i.e., current crocodile holdings and capacity).

Finally, there appears to be unnecessary mortality of hatchlings (up to 20%) once they emerge from the nest to the time they are delivered to AMCR, possibly due to how they are housed at the nesting beach prior to removal to the AMCR. We recommend that the AMCR management and scouts investigate this issue further and find a solution to reduce post-collection mortality of hatchlings before they arrive at the AMCR.

2.2.4. Compliance with CITES Resolution Conf. 11.12 - Universal Tagging

We found that the current system of monitoring, tracking and checking skin tag numbers during each export may not be sufficient to ensure all exported skins are derived from the ranching program now and in the future. This is a problem that occurred in Madagascar where it ultimately led to a trade ban, and this should be rectified.

We found that skin tags are ordered and managed directly by the SNNPRS when needed by the AMCR for export of skins. They report the serial numbers to EWCA for record keeping purposes. At the time of export, AMCR and SNNPRS authorities send a list of tag serial numbers affixed to skins to EWCA, which then compares this to the list of tag serial numbers affixed to skins provided by the exporter (e.g., Bale Leather Products). However, no EWCA representative appears to verify skin sizes and tags by checking the skins themselves prior to export. We recommend that EWCA monitor skin sizes and tag numbers prior to export to ensure to importing Parties that all skins are derived from the ranching program and that no avenue for larger, wild-harvested skins to be included in exports is possible.

2.3. Re-open Crocodile Trophy Hunting

Limited trophy hunting will not negatively or unsustainably impact the Nile crocodile population of Lake Chamo and the benefits derived justify the use of crocodile trophy hunting as a continued commercial incentive for increased stewardship of the wild population and assistance to improving livelihoods.

In 2007, Whitaker (2007) stated “the trophy hunting concession for crocodiles on Lake Chamo could at this time be detrimental to the goals of crocodile conservation and

development of tourism here and that it's better that exploitation of the crocodile population be limited to egg collection until we understand crocodile population dynamics, spatial distribution around the lake and tourism potential." By all appearances, this is not an unfair statement, especially with regard to the biological sustainability of trophy-sized animals (i.e., large males over 4.5 m total length). Our review results, however, indicate that this was a shortsighted perspective of the situation and did not consider the positive impacts the trophy hunting concession had on the Lake Chamo crocodiles - particularly with regard to law enforcement and community benefit. For example, to better manage their hunting concession, Ethiopian Rift Valley Safaris (ERVS) reported that they previously actively patrolled and controlled the lakeshore habitat for illegal mesh diameter fishing nets and actively managed the lakeshore habitat to facilitate crocodile nesting and basking. None of these stewardship activities were continued after the concession was closed in 2007, and the resulting impact on the wild population is probably much greater than the removal of small numbers of adult males.

As indicated by Whitaker (2007), definitive information on the impact of trophy hunting focused on the largest male demographic is scant. However, evidence from other crocodilian trophy hunting and wild adult harvest programs suggests that male-targeted harvests actually result in an increase in big males. For example, some 40,000 mostly male American alligators are harvested annually in Louisiana. Despite this, size of the largest individual taken has steadily increased over time and the average size of alligators taken has been stable (The Louisiana Department of Wildlife and Fisheries, Office of Wildlife 2013). Similarly, the harvest of adult male caiman in Venezuela results in an increase in body size in the harvested wild population relative to the non-harvested population (Velasco *et al.* 2003). One potential explanation of this phenomenon is that a few large crocodiles can prevent access to food and other resources constraining smaller individuals from getting larger. Once the largest animals are removed from the population, it frees resources for a large cohort of individuals to rapidly grow into the open niche.

Until this is demonstrated true for Nile crocodiles, however, we recommend taking a more precautionary approach and make the following suggestions:

- Nile crocodile trophy hunting on Lake Chamo should be licensed as part of one Controlled Hunting Area (CHA; closed concession managed by a single hunting operator with management obligations) to ensure the beneficiary has specified stewardship obligations scaled to the operation of the business, and collaborates with law enforcement efforts.
- The initial quota should be *up to* 5 individuals per year, to be set by EWCA after discussions with the regional authorities. Later adjustment can be based on objective criteria formulated by EWCA on the basis of survey data and such other management considerations as may be required.
- The permit fee for trophy-sized Nile crocodiles should be increased from a flat rate of \$US2000, to a sliding scale of perhaps \$US6,000 – \$10,000 based on the size of the trophy and other criteria, for example the hunting area (e.g., crocodiles hunted on the Omo River). This would require EWCA to reconsider the trophy fee pre-payment schedule now in place, perhaps accepting a minimum deposit with the

balance to be paid upon measurement of the trophy (note – this approach to trophy fees could benefit Ethiopia’s hunting industry as a whole). Suggested fees are:

- \$US10,000 for crocodiles over 5.2 m (17 ft)
 - \$US8,000 for crocodiles over 4.6 m (15 ft)
 - \$US4,000 for crocodiles over 4.25 m (14 ft)
 - \$US2,000 for smaller trophies
- The minimum trophy size for Lake Chamo could be set at 3.6 m (12 ft) to minimize the off take of females, though with such a small quota this is likely to have minimal impact and may not be an important criteria.
 - The system of biennial quota setting surveys should be reinstated. Unlike for other concession-based quota setting mechanisms in Ethiopia, however, EWCA and concessionaires may need to consider extending the surveys to include the entirety of Lake Chamo to compare rates of population change potentially linked to the improved stewardship and the trophy hunting. These surveys could be linked to the monitoring carried out in support of the hatchling harvest.
 - Nile crocodile hunting could be limited to outside of the nesting season (e.g., June to November) to ensure that any males taken as part of the harvest have been given a chance to contribute to the reproductive pool for that year.
 - Maintaining the placement of the CHA in the south of the lake, some 25 km from the tourist areas around the Crocodile Market, may be needed to ensure the hunting in this southern sector will not negatively impact the established tourist viewing activities in the north.
 - Nile crocodile trophy hunting could be extended to other sites in Ethiopia (e.g., Omo River, Gambella) if supported by survey results by EWCA for other CHAs. Though, trophy hunting should not be allowed in the Awash River drainage until the questionable presence of *Crocodylus suchus* is confirmed.
 - Wherever possible, trophy hunting can and should be linked to the alleviation of human-crocodile conflict.

2.4. Implement Nile Crocodile Population and Habitat Protection Measures in Accordance with Existing Ethiopian Law

The present state of fisheries-related law enforcement in the Nechsar NP area, and elsewhere in Lake Chamo, is a cause for concern. According to national park management regulations, fishing is technically prohibited within the park boundaries, but it is clear that this is currently rampant and difficult to enforce. The loss of crocodiles to drowning and the damage they cause to fishing gear, both within and outside of no fishing areas, are both negative problems for crocodile conservation and sustainable use (Chimbuya and Hutton 1987). We observed a large amount of fishing nets and trotlines (i.e., long lines with a series of baited hooks or single-baited hook lines) throughout the unprotected areas of the lake, where it seems the regulations on mesh type and size are also not enforced by the local fisheries authorities.

Unsustainable fishing would be directly linked to livelihoods in its own right, and is deserving of research. The real impact of fishing on crocodile populations is unknown and deserves quantification. For example, the supposed negative impact of fishing on crocodile populations may be overestimated by some of our interviewees as, despite the high fishing intensity, we found a healthy crocodile population in the lake. Much of the concern is, understandably, directed at incidental mortality of very large individuals (i.e., see the abundant collection of extremely large crocodile skulls at the AMCR and the Nechsar NP headquarters).

We strongly encourage EWCA to put special efforts into the law enforcement on Lake Chamo (e.g., additional boats, more scouts for security reasons patrolling and removing the nets, etc...), to better quantify the fishing dynamics, enforce fisheries legislation, and proactively mitigate negative impacts on the sustainable crocodile resource. In addition, EWCA should work with the SNNPRS and the zonal administrations to ensure continued successes in understanding and managing the burgeoning agricultural developments around the lakeshore, which could negatively impact fisheries and crocodiles alike.

2.5. Develop a Diversified and Sustainable Business Model for Arba Minch Crocodile Ranch

The commercial viability, and thus sustainability, of the AMCR is a matter of concern, because it has been running at a financial loss for a decade or more. We recommend that the AMCR should be either restructured to run as a private-government partnership still owned by the SNNPRS or be privatized entirely. In addition, the AMCR needs a product marketing strategy for its skins to try and capture international buyers and international market prices.

The AMCR is currently run as a government department with all important decisions made, and a budget provided, by the SNNPRS administration in Hawassa. It is likely to operate more efficiently if run as an independent business entity with its own budgeting, marketing, and business plan.

In addition, it is clear that the present AMCR business and marketing activities are not viable for long-term sustainability of the operation and need upgrading. For example, the last attempted sale of skins was done on a tender basis and, ultimately, not sold because only a single bid was received (i.e., not the requisite three). Though we understand this system of skin sales has already been revised.

The commercial viability of the AMCR, and its ability to internalize costs and income to achieve financial sustainability, could be improved through modest investment in more diversified income and employment opportunities. Some possible options (not exhaustive) are:

- A restaurant facility on the AMCR grounds could accommodate visitors. Given the current construction of an abattoir on site, meals with crocodile meat could even be served.
- A backpacker hostel or camping facilities (e.g., simple platforms with shared shower and toilet) on the AMCR grounds would cater to visitors. There is high

tourist visitation, and attractive surrounds, and the lack of other such facilities in the Arba Minch area suggests such a strategy may be viable.

- Foster the local, artisanal market for crocodile skins, skulls, teeth and other curios for sale to tourists at the AMCR and potentially at traditional craft goods market places (e.g., Churchill Road in Addis Ababa). This should be implemented in collaboration with EWCA to make sure the trade complies with national and CITES legal frameworks and is monitored and regulated both at points of manufacture, sale and export. Personal effects exemptions under CITES may negate the need to closely regulate souvenir products taken out the country by tourists.
- Improve the aesthetics of AMCR for tourists by clearing away junked vehicles, sheet metal, abandoned sheds, etc., and maintain a more attractive natural garden space.
- Improve the museum and visitor information center, which is currently in a more or less empty building with old photos, specimens and hand drawn figures. The AMCR could easily become a cornerstone environmental education experience for tourists and local school groups alike. Cooperation with Arba Minch University to develop educational materials and displays in multiple languages, including English, may be a practical pathway for achieving a cost-effective upgrade.
- Consider using the crocodile survey and harvest boats for tourist trips onto Lake Chamo when not being used for ranch-related activities. Running daily trips to the Crocodile Market or crocodile nesting beaches is a guaranteed, regular source of income.
- Consider offering egg or hatchling harvest experiences to tourists. For example, tourists could camp on the Lake Chamo shore with the AMCR scouts for a night to protect crocodile nests, transport eggs or hatchlings, photograph egg-laying females, etc. Depending on the nesting beach, people from the local community could be hired to maintain the campsite, cook local Ethiopian meals, etc.
- The abattoir presently being built on site could be opened up for non-crocodile slaughtering to simultaneously broaden the income base for AMCR and secure access to feed for crocodiles.
- Create and supply a market for crocodile meat at tourist venues throughout Ethiopia including hotels and restaurants in Addis Ababa, Arba Minch, and other urban/tourism centers. If the abattoir meets international health requirements, the possibility of selling crocodile meat internationally could be investigated.

Regards crocodile production itself, consideration should be given to:

- Develop and maintain a record keeping system, preferably electronic, on all aspects of the operation including annual surveys, hatchling harvest, mortality, feed, growth rates, culling, sale prices, etc., that is readily accessible and monitored to ensure an efficient ranch management process.

- The hatchling and yearling greenhouse grow-out facility needs to be repaired and returned to working order to maintain optimal growth temperatures.
- Hatchlings should be harvested from Lake Chamo annually or biennially regardless of whether the AMCR has the space or resources for additional stock. In years when there is no space or financial means to increase the AMCR stock, hatchlings could be sold to other Nile crocodile farming operations throughout Africa and the Middle East. The additional advantage this would have is ensuring nest protection and AMCR presence within Lake Chamo communities for continued environmental education and sensitization annually.

2.6. Management of Human-Crocodile Conflict

Crocodiles represent a real threat to people and livestock, and people represent a real threat to crocodiles, hence achieving a balance between both can and should be a goal of management.

Establishing an improved management model for crocodiles, which is linked with an improved fisheries management model for Lake Chamo outside Nechsar NP, seems essential for reducing these threats. Trophy hunting, and more active habitat management and protection of nesting and basking beaches, puts more responsible people in the field with crocodiles for more time, which will help reduce HCC in both directions. That being said, we found that the current level of threat to local communities is rather low, but it is impossible for us to comment on trends, as no historical data is available.

If the AMCR adopts a more diversified business model exploiting increased ways of utilizing the crocodile resources (see Section 2.5), it would all help increase community awareness and likely open new options to provide benefits to the local people from crocodiles. The possibility of a small fund for compensating fishermen for net damage or repair due to crocodiles may be a cost-effective way of winning their support for ongoing crocodile conservation.

2.7. Additional Recommendations

2.7.1. Monitoring/Survey Methodology

Ethiopia's national hunting and other wildlife harvest regulations prescribe regular, usually biennial, surveys in the CHA's and other harvest sites. We found that the method currently implemented by EWCA and the SNNPRS could be improved to better detect changes in population size given that intentional utilization is not the only activity resulting in crocodile off-take from the lake (i.e., mortality in fishing nets). Currently, the surveys are conducted during the day only (though specific times are unavailable in most reports) and cover the full lakeshore following the procedure outlined by Bolton (1984). It is unclear how many observers are usually counting crocodiles. The presented results are usually converted by a correction factor of 1.8 to account for the differences in day and night counts. And, most reports that we read included statements about changes in population size since the last survey (usually 3-5 years previous) based on these corrected daytime counts. We refer to our discussion in Section

3.5.3 for a detailed explanation about why this current monitoring methodology limits the ability to base management decisions on survey results. Some recommendations for future efforts are:

- Surveys should ideally be conducted annually – at least until trends are well established, and then survey frequency can be modified based on those trends and the desired level of detection of population change.
- Surveys during the same time of year would account for seasonal effects on visibility (day or night surveys) and improve comparability of results across time. December to February may be best as it would align with the nesting survey needs for the annual AMCR harvest, but the decision may ultimately need to be made after consideration of water levels, temperatures, and their effects on the visibility of crocodiles during surveys. Lower water levels will generally increase the proportion of crocodiles seen, for example.
- We recommend that night surveys be adopted as the preferred standard technique in order to best detect all size demographics. Night surveys should take place from 30-60 minutes after sunset to no later than 0200 h and should be planned to correspond as closely as possible with the new moon (i.e., moonless nights). Ideally, surveys will take place on relatively wind and wave free nights to ensure higher detection rates.
- Any daytime surveys should be carried out during the hours of the day less likely to have high wind and waves and before the peak daytime temperatures (i.e., mid- to late-morning and/or mid- to late-afternoon).
- The raw count data (i.e., relative density) without the currently used correction factor is more than adequate to detect trends over time (i.e., is the population, or different cohorts within it, increasing, decreasing, or stable). Correction factors accounting for aspects of detection probability (e.g., submersion) across different size classes may be needed to estimate absolute densities if this is required. But, in the absence of research to better approximate real detection probabilities (i.e., accounting for observer bias, environmental factors, and submersion bias) and in the presence of regular (e.g., annual) monitoring, the current use of the day count correction factor is not meaningful.
- To gain insights into how environmental factors may affect detectability, data on air and water temperature, wind, waves, precipitation, cloud cover, and moon phase, as well as survey start/end time, place, and duration/length should be recorded for all surveys, so that if needed later corrections are possible. Multiple surveys at different times over one year may help refine this from the start.
- Where possible, the size of sighted crocodiles should be estimated in broad categories (say 0.5 m or 1 foot size classes) so that changes in demography can be quantified. Any unclassifiable crocodiles can be recorded as *eyes only* (EO).

- A GPS point should be taken for each individual/aggregation of individuals. If GIS expertise is not available for spatial analysis, even simply visualizing these points in Google Earth from year to year may provide insights into the spatial distribution of crocodiles with management significance. For example, where the crocodiles are relative to fishing, agricultural, and other development activities on the lake, and how this may change over time (or seasonally if multiple surveys are conducted in one year).
- We recommend that Lake Abaya, or at least portions of it (e.g., Nechsar NP shoreline), are surveyed every 1 - 4 years to account for the possibility that changes in the Lake Chamo population are influenced by immigration and emigration to and from Lake Abaya. This will additionally provide information about possible harvest or hunting areas outside Lake Chamo.
- Should EWCA decide to open crocodile trophy hunting nationally, surveys of all controlled hunting areas with crocodile populations will be required annually or biennially.
- A nationwide survey should be considered to assess general trends in the distribution and abundance of the total Ethiopian Nile crocodile population, with the whole or different parts of the survey area revisited over longer time periods – say every 5 years.
- All survey data, results, and reports should be compiled in electronic databases available to EWCA, SNNPRS, and the AMCR, as well as made publicly available to researchers and others with an interest in crocodile status in Ethiopia.
- With a survey database established, efforts should be made to collect and collate any historical survey results that can be gathered, so that objective insights into the historical distribution and abundance of crocodiles, essential for establishing realistic conservation goals, can gradually be assembled.

2.7.2. Student Involvement

There remain many outstanding questions about the biology and management of the Lake Chamo Nile crocodile population. Students in the Biology Department of Arba Minch University (AMU) are well positioned to conduct small research projects for their advanced undergraduate and Master's degrees that will significantly improve crocodile management. For example, at the time of writing this report AMCR expert Ehit Bekele was awarded a grant from the Crocodile Specialist Group's Student Research Assistance Scheme (<http://www.iucncsg.org/pages/General-Information.html>) to investigate hatching success at protected versus unprotected nesting sites and the effect of different feeding regimes on hatchling growth at the AMCR. We recommend that EWCA, SNNPRS and AMCR make every effort to work collaboratively with the AMU's Biology Department to support student projects which can inform on some of the above identified issues for better management of the Lake Chamo crocodile population.

3. THE REVIEW MISSION

Prior to reading this more extensive discussion of our review mission, we would like to clarify that the discussion here focuses more extensively on policy and administration of the greater Nile crocodile utilization scheme in Ethiopia. In contrast, the Whitaker (2007) report focuses more heavily on Lake Chamo itself and the history of crocodiles and crocodile surveys in the lake. Where possible, we avoided repeating information from the 2007 report and, as such, consider it an essential companion read to our report.

3.1. Administration

The Ethiopian administration responsible for managing wildlife and wildlife resources occurs at the federal, state, and zonal levels. However, communication and feedback loops between these different levels of governance are obviously complicated, posing a problem for the sort of integration of effort and responsibilities needed to comply with international wildlife conventions like CITES. We describe that administrative framework here, as we came to understand it, drawing attention to known and potential problem areas related to crocodile management.

3.1.1. Administration at EWCA

Wildlife Utilization and Market Development Directorate, EWCA (Hailu Zerfu, Acting Director): This directorate is the CITES Management Authority of Ethiopia and fulfills the duties of that role for both CITES-regulated and unregulated, but still traded, species under Ethiopian law. This includes issuing permits for hunting and wildlife trade, enforcing permit conditions, determining annual quotas of hunted and harvested species, and ensuring that international wildlife and biodiversity treaties are implemented in a manner compatible with Ethiopian laws. The Wildlife Utilization and Market Development Directorate should play a central role in Nile crocodile utilization programs for the reasons listed above and, it would appear to be the best focal point for record keeping, analysis of non-detriment, and reporting.

Wildlife and Wildlife Products Trafficking Directorate, EWCA (Daniel Paulos, Director): This directorate is responsible for the control of illegal hunting and trafficking of wildlife and wildlife products. Its goal is to ensure that all trade of endangered, or otherwise protected, species is done in accordance with Ethiopian law, and that wildlife products in trade can be identified to ensure they are traded in accordance of the law and permit conditions. The Wildlife and Wildlife Products Trafficking Directorate has an important potential role to play with all crocodile products, through inspection at various control choke points including at AMCR, tanneries and the airport.

Wildlife and Wildlife Habitat Research Directorate, EWCA (Kahsay Gebre-Tensae, Director): This directorate is responsible for conducting wildlife population and ecosystem assessments, researching endangered and endemic species, drafting

research guidelines, evaluating wildlife and ecosystem research proposals, establishing linkages with universities, institutions and the private sector engaged in wildlife research, and, through monitoring all of the above, ensuring that appropriate management-related data and recommendations are forwarded to area, species, and program managers. It seems that this directorate's activities are limited to areas outside of protected areas, although it is unclear. Conversations with EWCA personnel indicate that this directorate should function as the CITES Scientific Authority within EWCA, though it is unclear the degree to which this is being implemented at this time.

National Parks and Wildlife Sanctuaries Coordinating Directorate, EWCA (Kumara Wakjira, Director): This directorate is primarily responsible for overseeing the management and implementation of Ethiopia's federal wildlife protected areas, including coordinating with a diverse range of stakeholders within EWCA, nationally and internationally for the proper management of species, ecosystems and tourist activities, as well as training and law enforcement within protected areas. The National Parks Directorate of EWCA should play a significant role in Nile crocodile management by facilitating the development and regulation of tourist visits to the "Crocodile Market," for example, as well as ensuring that Nechsar NP can function as a crocodile sanctuary by controlling illegal fishing, grazing, and nesting habitat modification activities inside the park, which accounts for nearly 40% of the entire Lake Chamo shoreline.

Wildlife Development and Protection Directorate, EWCA (Zelege Tigabe, Director): This directorate has the role of Wildlife and Wildlife Habitat Research Directorate within protected areas, and establishes the legal and administrative basis for new protected areas within Ethiopia, including trans-boundary initiatives. It is unlikely that the Wildlife Development and Protection Directorate will have an extensive role in Ethiopian crocodile management.

Community Partnership and Conservation Education Directorate, EWCA (Genet Gardew, Director): This directorate is responsible for conducting socio-economic surveys within and around protected areas and other important wildlife sites, assessing community integration into wildlife and natural resources management programs, ensuring that local communities benefit from eco-tourism, working with local communities to mitigate or compensate human wildlife conflict, and developing educational materials and programs for the long-term *environmentality* of Ethiopia. The Community Partnership and Conservation Education directorate should play an important role in Ethiopian Nile crocodile management by liaising with Lake Chamo communities to ensure they have a vested interest in the sustainability of the population including HCC mitigation, habitat and nest site protection, fisheries management, and deriving benefits from hatchling harvests, trophy hunting and tourism.

3.1.2. Administration from the Southern Nations, Nationalities, People's Regional State (SNNPRS)

Bureau of Culture and Tourism (Shigute Tiyyite, Acting Bureau Head and Deputy Bureau Head): This bureau is one of the regional bureaus responsible for the overall development of culture and tourism in the regional state. The bureau is organized into two departments: Culture Study and Development, which is responsible for study, conservation and development of culture, language and arts of the nations, nationalities, and peoples of the region; and, Parks and Tourism Development Department, which is responsible for tourism development and the management of protected areas in the region (including AMCR).

Parks and Tourism Development and Utilization Department (Shigute Tiyyite, Head of Department): This department's role is identifying, demarcating, establishing, managing and administering protected areas (national parks, sanctuaries, wildlife reserves, CHAs, and public wild species ranches or farms) that are not under the administration of EWCA. It is also responsible for allocating the budget, recruiting employees, and overall monitoring and supervision of these areas. The department has a joint venture with EWCA on wildlife utilization issues like biennial wildlife censuses for harvest and hunting quota setting. This department performs wildlife and wildlife products trafficking, community awareness, stakeholder consultation, and other wildlife conservation-related activities in the region. The department is not only responsible for the implementation of national wildlife conservation policies, strategies, proclamations, laws and regulations, but is also mandated to formulate regional policy, strategy, proclamations, laws, regulations and directives that are aligned to the national framework.

3.1.3. Administration at the Arba Minch Crocodile Farm

Office of Arba Minch Crocodile Ranch (Dr. Tigist Ashagere, Director): Arba Minch Crocodile Ranch is responsible for the overall husbandry of crocodiles at the ranch, including protection, feeding, hygiene, medication or treatment, age-based segregation, and keeping data related to these activities. It is also responsible for monitoring nesting grounds and collecting crocodile eggs or hatchlings both for the ranch, as well as the private ranch located in Arba Minch. The ranch also works in collaboration with the local administrators, Nechsar NP management, and other stakeholders in the conservation and management of crocodiles and their natural habitat on Lake Chamo.

Ehit Bekele, AMCR Expert: Responsible for supervising the day-to-day husbandry practices of the ranch, as well as nest identification, monitoring and hatchling collection activities on Lake Chamo. She is responsible for conducting crocodile-related ecological surveys and for performing crocodile conservation-related community awareness programs around Lake Chamo.

3.1.4. Legal Framework

The following regulations appeared in the 20 August, 2007 Federal Negarit Gazeta under the “Development Conservation and Utilization of Wildlife Proclamation” (No. 541/2007) and apply to the management of Nile crocodiles in Ethiopia and, specifically, Lake Chamo:

- Article 4 provides authority for the Federal administration of national parks meeting certain criteria, and because of this Nechsar National Park is administered by EWCA.
- Article 5 provides authority for the Regional state administration of wildlife controlled hunting areas, meaning any “closed” hunting concessions for Nile crocodiles on Lake Chamo are administered by the SNNPRS.
- Article 6 provides both the Federal and Regional state administrations with the authority to authorize private investors to administer wildlife conservation areas. This could include wildlife controlled hunting areas, but these are normally given to hunting operators through concession agreements that leave the management authority with the region.
- Article 12 prohibits the trade in wildlife and wildlife products, as well as the ownership, sale, and export of any processed or unprocessed wildlife product except under permit from EWCA or the appropriate Regional organ. Unfortunately, this does not clarify a hierarchy in the case of both federal and regional stake in wildlife and wildlife products - one example of a grey area in the crocodile ranching and trophy hunting administration.
- Article 13 provides EWCA (or generally the Ministry of Culture and Tourism) with the authority to issue hunting permits to foreign tourists, issue permits to export wildlife and wildlife products, ensure that wildlife conservation areas (including controlled hunting areas) meet international standards (including those outlined by IUCN), ensure the implementation of treaties to which Ethiopia is party (including CITES, where EWCA is listed as both the Management and Scientific Authority), provide support to regional administrations concerning the development and conservation of wildlife (though does not seem to mandate a specific relationship), and to delegate these powers to regional administration organs where necessary.
- Article 14 provides the Regional state authorities the authority to control illegal wildlife activities both in and out of wildlife conservation areas under their administration (including supporting EWCA in such efforts), issue permits for the establishment of and supervise wildlife ranches and farming (including AMCR and the Blen Development PLC, as well as any future ranches), undertake to study and mitigate human wildlife conflicts, issue hunting permits to national and foreign residents, and issue permits to own, transfer, and sell locally wildlife and wildlife products.

- Article 16 states that any person committing an act of illegal wildlife hunting or trade, carrying out unauthorized activities within a wildlife conservation area (including national park or controlled hunting area) that damages the area (including illegal fishing), or is found in possession of wildlife or wildlife products will be subject to a fine of 5000-30,000 birr (\$US250-1500) and/or imprisonment of 1-5 years.

In 2008, the Ethiopian Council of Ministers issued proclamation 163/2008 entitled “Wildlife Development, Conservation and Utilization”. This proclamation updates the national wildlife laws decreed in proclamation 541/2007 and, additionally, stipulates the following that may be implicated in national Nile crocodile management:

- Article 4 provides a list of wildlife conservation areas that are to be managed by EWCA, specifically mentioning Nechsar NP, Omo NP and Awash NP, which may contain significant crocodile populations. All other wildlife conservation areas fall under Regional State administration.
- Article 5 provides a list of activities prohibited in national parks, including hunting and fishing, agriculture or cultivation, grazing and watering domestic animals, or removing wildlife products. The article further clarifies possible exemptions, few of which seem to apply to Nechsar NP.
- Article 6 details the delimitation and concessions granted for hunting wildlife, including controlled hunting areas.
- Part Three (Articles 8-25) details the hunting permits. Points relevant to crocodile trophy hunting include forbidding the hunting of females (Article 15), removing or adding species eligible to be hunted based on review of population and habitat status (Article 18), methods by which crocodiles can be hunted (Article 25).
- Article 27 discusses the obligations of wildlife dealers in order to legally trade parts such as crocodile skins, teeth, skulls, other curios and finished products.
- Article 29 discusses the exportation of wildlife products including valid ports of export and CITES permits provided by EWCA.
- Article 33 affords the right to kill wildlife in defense of one’s life and kill wildlife damaging property. The article further stipulates that, when possible, persons should inform the relevant authorities in advance of such killing and render any wildlife products back to said authorities.
- Article 36 states that EWCA will transfer back 85% of revenues generated from wildlife hunting, live export, and filming to the concerned region.

- Table II details fees for the issuance and renewal of certain licenses, notably 3000 birr (\$US150) to trade live wildlife, 2500 birr (\$US125) to trade wildlife products, 3000 birr (\$US150) for taxidermy, 4000 birr (\$US200) for a crocodile farming license, and assorted hunting fees. For these listed licenses, it does not specify if the fee is on a unit/incident or temporal basis.
- Table III details fees for crocodile units. Notably crocodile hatchlings can be sold at \$US2 each to foreign investors, 15 birr (\$US0.75) to Ethiopian investors, and 5 birr (\$US0.25) to farmers for quantities in excess of 100. Crocodile eggs are sold at half those prices.
- Table IV lists the Nile crocodile as a species allowed to be hunted by foreign tourist hunters for a \$US2000 trophy fee.
- Table V excludes Nile crocodiles as a species available to resident hunters.
- Table VIII is the list of species eligible for live trade and Nile crocodiles are not included.
- Table IX lists the export fees for wildlife products including 150 birr (\$US7.50) per skin (except skins from ranches which are exported for 7.50 birr (\$US0.50) each), 100 birr (\$US5) for a large “carpet” [*Note – the CSG does not understand what product this is meant to represent – but may be a portion of the, as opposed to a complete, skin*], 180 birr (\$US10) for a head mount, 110 birr (\$US5.55) for a full mount, and 50 birr (\$US2.50) for a skull. There is no export fee for crocodile teeth or eggs. We would like to point out that there are considerable inconsistencies in this pricing regime. For example, a head mount is more expensive than a full mount, which is in turn more expensive than a full skin. We recommend revising this pricing scheme.

The above-detailed proclamations provide the legal framework for managing the Ethiopian crocodile resource including sustainable utilization, protection and tourism at both the Federal and Regional state levels. The shortcoming in the legislation seems to be the implementation of interaction between the federal and state administrations for the management of the crocodile resource where both the federal and regional administrations seem to have partially overlapping and partially exclusive authority over the two major sustainable utilization activities.

For example, EWCA establishes the crocodile trophy-hunting quota internationally and nationally, but SNNPRS administers and regulates the hunting concession on Lake Chamo. EWCA is responsible for regulating the international trade in crocodiles and crocodile parts, including requesting the annual quota from CITES for ranches and trophy specimens, but SNNPRS seems to be solely responsible for setting the hatchling harvest quota and managing the development of crocodile products locally until they are ready for the international market, and there does not

appear to be any correlation between the federal trade quota and the regional harvest quota.

EWCA is responsible for the protection of crocodiles in the wild, including any activities which may involve them being removed from the wild, except where it concerns ranching in which case SNNPRS appears to have complete autonomy. The two levels of administration are encouraged to collaborate with each other in these management instances, but this does not appear to be realized and often one or the other is simply not aware of the other's, or their own, activities or obligations. It is in this regard that an *Integrative Ethiopian Crocodile Management Plan* is recommended, which allocates responsibilities and manages inter-agency feedback loops with more clarity.

3.1.5. Policies and Laws to Monitor and Regulate Crocodile Trade

Regulations 541/2007 and 163/2008, detailed above, specify several crocodile trade-relevant policies, including management of protected areas and controlled hunting areas, harvests and ranches, and license and export fees. EWCA is recognized as the CITES MA and SA, and is responsible for wildlife trade and trafficking monitoring and law enforcement. Beyond this, however, we were not provided documentation that detailed specific policies or laws regards other aspects of trade monitoring and regulation. In discussions with EWCA, SNNPRS, and AMCR officials, it appears that biennial population surveys should have been carried out as part of the Nile crocodile CHA on Lake Chamo and that EWCA is responsible for requesting annual CITES export quotas for both trophies and skin products, while AMCR seems exclusively responsible for establishing the annual hatchling harvest quota independent of existing export quotas (see below).

3.2. Management

3.2.1. Crocodile Management Plan

Despite Ethiopia's crocodile population being subject to two different sustainable utilization regimes (currently and/or in the recent past), as well as figuring heavily in localized tourism activities, there is no crocodile management plan at either the zonal, state, or federal levels. It seems as though a comprehensive species management plan has never existed. The only species-specific management plans that exist currently in Ethiopia are for certain endemic and/or endangered mammals (e.g. Ethiopian wolf, cheetah, lion, elephant), but that crocodiles are implicated so heavily in issues of zonal, state, federal, and international administrations, whose legislative authorities/hierarchies are often unclear, necessitates an interagency cooperative management plan. Development of such will be critical to the long-term sustainability and success of the crocodile resource. **This is our primary recommendation.**

3.2.2. Extent of Human-Crocodile Conflict

It was reported to the CSG that human-crocodile conflict (HCC) in Ethiopia may be increasing and, if true, would likely be a critical issue for future crocodile management efforts both in Lake Chamo and nationwide. Discussions with EWCA representatives indicated that no focused effort had been made to investigate this issue and that concerns were mostly coming from intermittent anecdotal reports, not all of which originated from Lake Chamo. Other reports of HCC in Ethiopia can be found in the CrocBite database (<http://www.crocodile-attack.info/>), as well as in agency reports and the popular media.

During our survey work on Lake Chamo we took the opportunity to discuss the local extent of HCC with several fishermen. Our interviews, though limited, did not clarify where reports of *increasing* HCC on Lake Chamo originated and we found that this may not actually be the case. Discussions with EWCA personnel (including in Addis Ababa and Nechsar NP), ERVS representatives, and local fisherman, all revealed that HCC, in the form of crocodile attacks on people and livestock, exist on Lake Chamo, but our inquiries do not support the view that the HCC problem is increasing or that people feel exceedingly threatened by it.

For example, one fisherman interviewed in Lake Chamo zone 7 stated that in the preceding 6 months crocodiles took 6 cows and 3 people. A second fisherman interviewed not more than a couple of kilometers away stated that only a single human was taken in the preceding 12 months and did not mention cattle. Interviews at the largest fishing village on the lake, in zone 5, revealed that no humans had been taken and only rarely were cattle prey to crocodiles.

It is unclear why these discrepancies existed, but the end result is that none of the respondents gave the impression of truly being fearful for their lives from crocodiles, despite all fishermen on the lake using small raft-style crafts to set and check nets (Fig. 1). The fishermen in zone 5 said that they recognize crocodile attacks as a potential issue and, therefore, typically limit their fishing activities to the period after dawn to before sunset. But during these hours we observed fisherman in the water, sometimes up to chest level, not far from large crocodiles indicating that the threat cannot possibly be imminent.



Fig. 1 Lake Chamo Fisherman use small, raft-style crafts to navigate the lake and its large population of Nile crocodiles and hippos.

As indicated above, however, all fishermen were candid in revealing that they are using more nets of smaller mesh sizes in response to a decline in the fisheries (consequently, this likely also suggests that fisheries management and control on the lake is limited). As observed by Whitaker (2007), and virtually all other parties conducting crocodile surveys on Lake Chamo, reverse HCC (i.e., people attacks on crocodiles) is an unquantified problem. We only found a single drowned crocodile during our surveys, but fisherman indicated that crocodiles destroy and/or get tangled in nets frequently. In several areas of the lake, we observed that the predominant net placement was along the vegetation/open water interface essentially ensuring net destruction or entanglement by any crocodiles that passed into or from open water.

3.2.3. CITES Legal Frameworks

The following CITES legal frameworks apply to Nile crocodile utilization and trade in Ethiopia:

- Article IV - for trade in species listed under Appendix II, the onus is on the producing country (Ethiopia) to demonstrate that the commercial activities are not detrimental, or indeed beneficial, to the wild populations. In the case of Ethiopia, our review found that the current trade practices are not detrimental to the Nile crocodile population, but due to the lack of an operational CITES Scientific Authority and significant deficiencies in record keeping and population monitoring, the EWCA is not in a strong position to demonstrate that it is satisfying the criteria of Article IV.
- Article VII (*Exemptions and Other Special Provisions Relating to Trade*) and Resolution Conf. 13.7 (Rev. CoP16) *Control of trade in personal and household effects* - stipulates that parts or derivatives listed under Appendix II do not need to be accompanied by a CITES permit if they are for non-commercial (i.e. personal) uses. Currently, Ethiopia does not apply this Resolution because there is no local trade in artisanal, worked products or curios. However, one of our recommendations is that EWCA consider authorizing trade in worked leather products, teeth, skulls, and other curios for sale to tourists as souvenirs and personal effects at AMCR or shops in Addis Ababa (e.g. along Churchill Road).
- Resolution Conf. 11.12 (Rev. CoP15) *Universal tagging system for the identification of crocodilian skins* - stipulates that all traded Nile crocodile skins must be affixed with a CITES-approved, non-reusable tag meeting certain criteria regarding identifying information. The Resolution also stipulates that the exporting countries devise and implement a system by which tag numbers can be monitored, traced, and checked at points along the export chain. Currently Ethiopia orders its skin tags from Albco (Pvt) Ltd of Zimbabwe. We found two potential issues regarding this Resolution in Ethiopia. First, EWCA only seems to receive information about skin tags when they are already attached to skins for export and not before. Second, EWCA appears to rely on information

reported by AMCR and the exporter (e.g., Bale Leather) with regard to the tags affixed to skins to be exported and does not appear to inspect the skins and tags being exported to ensure that illegally-sourced skins are not being affixed with legal tags. We do not feel this is likely to be a problem, but believe EWCA should make every effort to inspect skin shipments prior to them leaving Ethiopia. Apparently, most crocodile hunting trophies exported to date have been full mounts, in which case the skin tag must accompany the mounted specimen, but it is unclear whether Ethiopia has put in place a tagging system for exporting other trophies (e.g. skull or head mounts).

- Resolution Conf. 11.16 (Rev. CoP15) *Ranching and trade in ranched specimens of species transferred from Appendix I to Appendix II* - stipulates the definition of ranching and ranched specimens to include individuals removed as eggs, or other life stages, from the wild which otherwise have a very low probability of survival for rearing in captivity. Ethiopia's Nile crocodile production is based on ranching of specimens obtained as eggs/hatchlings from Lake Chamo. The Resolution additionally stipulates that the ranching country must have in place effective population monitoring protocols, harvest-level controls, inventory and stock monitoring systems, reporting both nationally and back to the Secretariat on various aspects of the ranching operation. We found that EWCA, SNNPRS, and AMCR authorities are not fully complying with this Resolution, especially with regard to the monitoring of wild populations and ranch stocks, record keeping and reporting.
- Resolution Conf. 14.7 *Management of national established export quotas* - stipulates that countries may establish and request export quotas for species listed in Appendix II given that they can document the requested quota will be non-detrimental to that species. In the case of Ethiopia's Nile crocodiles, we found that Ethiopian authorities are not meeting the requirements of this Resolution as the international quota setting is completely detached from the national harvest quota setting process. Further, population monitoring does not occur at regular enough intervals to ensure the application of an adaptive management process in the event that commercial activities do start to have a detrimental impact on Ethiopia's Nile crocodile population. Finally, the CITES Scientific Authority should establish export quotas on the basis of a non-detriment finding; this is currently a non-existent in practice in Ethiopia.
- Resolution Conf. 16.7 *Non-detriment findings* (NDFs) - stipulates that through the CITES Scientific Authority, countries must demonstrate that commercial activities are not detrimental to wild populations of traded species. The Resolution provides a list of measures and activities to guide the national authorities in determining NDFs. It was our general finding that Ethiopia's crocodile utilization activities are not detrimental to the population, but that the current administrative systems and policies are not adequate enough to document or report NDF. This is of particular concern for the long-term viability of Ethiopian Nile crocodile trade and the avoidance of CITES trade sanctions.

3.2.4. IUCN-SSC Guiding Principles on Trophy Hunting

In 2012 the IUCN-SSC established the “*Guiding Principles on Trophy Hunting as a Tool for Creating Conservation Incentives*,” that set forth SSC guiding principles on the use of “trophy hunting” as a tool for creating incentives for the conservation of species, their habitats, and for the equitable sharing of the benefits of use of natural resources (IUCN/SSC 2012). The document outlines five generalized principles that, when properly abided, should ensure the use of trophy hunting as a conservation and management tool for wildlife. Here we paraphrase these guidelines and discuss our review mission findings relevant to Nile crocodile trophy hunting for each.

3.2.4.1. Biological Sustainability

The guidelines state that trophy hunting can serve as a conservation tool when it does not contribute to long-term population declines of the hunted species; does not substantially alter processes of natural selection and ecosystem function generally requiring that hunting off-take produces only minor alterations to naturally occurring demographic structure; does not inadvertently facilitate poaching or illegal trade of wildlife; and does not artificially and/or substantially manipulate ecosystems or their component elements in ways that are incompatible with the objective of supporting the full range of native biodiversity.

The largest concern regarding the biological sustainability of crocodile trophy hunting in Lake Chamo is the unknown (to date) impact it may have on the “very large male” (i.e., over 4.5 m TL) demographic. This is clearly the targeted sub-population for trophy hunting and, while Lake Chamo is famous for its concentration of individuals in this demographic, the degree to which they are replaced (i.e., recruitment) is unknown. Some losses of large animals certainly also occur as a consequence of fishing practices, legal or illegal: for example the use of gancho nets and the placement of gill nets along the vegetation/open water interface.

Other crocodilian hunting/harvest programs globally, however, indicate that neither may be a significant concern. For example, the extensive annual harvest of wild alligators in Louisiana (some 40,000 per year), which mainly targets big males, has reduced neither the mean size of animal taken over time nor the size of the largest animals taken (The Louisiana Department of Wildlife and Fisheries, Office of Wildlife 2013). That is to say the genetic and environmental factors resulting in large size (including individual high growth rates) may simply be part of the normal distribution around the mean maximum size.

Accordingly, our review mission found that it is unlikely that the limited trophy hunting of crocodiles proposed in Lake Chamo, or throughout Ethiopia, will have any long-term adverse effects on the crocodile population as a whole. Any impacts on demographic structure (e.g., reduction in very large males) can also be overcome by reducing incidental harvest pressure (i.e., reduction in gancho net mortalities). Because of this, **we found that trophy hunting can and should be restarted**, though with annual monitoring and evaluation of harvest records to quantify sustainability. A trophy hunting program may well have a net positive impact on the population as a whole, especially by increasing management/stewardship activities, including better management of nesting and basking habitats, improved law enforcement, increased surveys (see 3.2.4.5), incidental or targeted environmental education, and with potentially increased community benefits (see 3.2.4.3).

In the three years that ERVS managed the controlled crocodile hunting area, largely centered on zone 7 in the southwest of the lake, they actively managed the lakeshore habitat by clearing vegetation from crocodile nesting and basking beaches. While there is no quantitative evidence to document the benefits of this practice to the crocodile population, our surveys didn't reveal any basking concentrations of crocodiles or obvious nesting sites in this zone, which was apparently not the case during the ERVS tenure (Roussos and Roussos 2007).

3.2.4.2. Net Conservation Benefit

The guidelines state that trophy hunting can serve as a conservation tool when it is linked to identifiable parcels of land where habitat for wildlife is a priority and on which the “costs of management and conservation of biological diversity [are] internalized within the area of management and reflected in the distribution of the benefits from the use;” produces income, employment, and/or other benefits that generate incentives for reduction in pressures on populations of target species such as creating incentives for local residents to co-exist with such problematic species as animals considered to be dangerous or a threat to the welfare of humans and their personal property; and is part of a legally recognized governance system that supports conservation adequately and of a system of implementation and enforcement capable of achieving these governance objectives.

Ethiopian law (see Section 3.1) is already structured in a way that allows Nile crocodile trophy hunting to provide a net conservation benefit for both the people and the crocodile population; however, it seems that in the past this was not fully realized. Previous crocodile trophy hunting in Ethiopia was more or less confined to Lake Chamo. By extending crocodile trophy hunting to other areas in the country, at least on a limited,

opportunistic basis, EWCA will be in a position to ensure greater returns from the activity while not increasing pressure on a single population. Previous hunting was managed as part of a single concession allocated to a single operator - ERVS - and by all appearances, for the more conservation-minded concessionaires, this system not only ensured a vested interest in the long-term, sustainable management of the crocodiles and the habitat in the concession, but also resulted in increased management action. ERVS were, apparently, involved in supporting fisheries law enforcement, habitat management (e.g., maintenance of basking and nesting beaches), and they employed local community members to support these efforts (Roussous and Roussous 2007). These activities all contributed to the “net conservation benefit,” regardless of any impact of taking trophy-sized animals.

3.2.4.3. Socio-Economic-Cultural Benefit

The guidelines state that trophy hunting can serve as a conservation tool when it respects local cultural values and practices and is accepted by (and preferably, co-managed and actively supported by) most members of the local community on whose land it occurs; involves and benefits local residents in an equitable manner and in ways that meet their priorities; and adopts business practices that promote long-term economic sustainability.

Nile crocodile trophy hunting in Ethiopia, and the Ethiopian legal framework to date, are only partially set-up to ensure socio-economic-cultural benefits as proposed in the IUCN guidelines. For example, there do not appear to be relevant cultural values and practices as relates to local communities, as Ethiopians do not traditionally utilize the crocodile resource outside the contemporary, international, commercial context. That being said, there are certainly land and fisheries management implications where traditional practices do not seem to negatively impact the Nile crocodile population (i.e. as evidenced by the existing crocodile population and its reproductive output), but more contemporary practices, like the expansive agricultural developments and associated settlements on the Lake Chamo shoreline or the extensive use of gancho nets, could conflict with this requirement. As discussed above, local Lake Chamo fishermen seem to have little fear of the crocodiles despite the pervasive, even if low frequency, rate of conflict. Trophy hunting and its benefits provide a viable management response to this in the socio-economic-cultural context.

3.2.4.4. Adaptive Management: Planning, Monitoring, and Reporting

The guidelines state that trophy hunting can serve as a conservation tool when it is premised on appropriate resource assessments and/or monitoring of hunting indices upon which specific quotas and hunting

plans can be established through a collaborative process that uses the best science and technology feasible to outline objective quotas and hunting plans; involves adaptive management of hunting quotas and plans in line with results of resource assessments and/or monitoring of indices ensuring quotas are adjusted in line with changes in the resource base; is based on laws, regulations, and quotas that are transparent, clear, and periodically reviewed and updated; monitors hunting activities to verify that quotas and sex/age restrictions of harvested animals are being met; and produces reliable and periodic documentation of its biological sustainability and conservation benefits (if this is not already produced by existing reporting mechanisms).

Ethiopia's policies and actions to date suggest that they have a system in place that can address this issue. For example, biennial surveys are used to set quotas in CHAs, trophy hunting was shut down in 2007 when it seemed the impact may be detrimental (Whitaker 2007), and EWCA and regional scouts accompanied every hunt to ensure compliance with the trophy hunting permit conditions. But there are also shortfalls. For example, while trophy hunting was open from 2004-2007, and two quota-setting surveys were supposed to have been conducted, only one took place (Wakjira *et al.* 2004). If EWCA decides to re-implement trophy hunting, annual population monitoring is recommended, at least in the short-term, to ensure quotas are conservative and that the management process can be adapted if need be.

3.2.4.5. Accountable and Effective Governance

The guidelines state that trophy hunting can serve as a conservation tool when it is subject to a governance structure that clearly allocates management responsibilities; accounts for revenues in a transparent manner and distributes net revenues to conservation and community beneficiaries according to properly agreed decisions; takes all necessary steps to eliminate corruption; and ensures compliance with all relevant national and international requirements and regulations by relevant bodies such as administrators, regulators and hunters.

The Ethiopian legal framework, as described above, is already structured to meet this recommendation because it allocates responsibility for different aspects of hunting management to the Federal and Regional State authorities. It is prescribed by the regulation 163/2008 that 85% of the trophy fee and 100% of the concession fee collected at the federal level is allocated to the regional state where the hunting takes place. It is then up to the regional state government to use and distribute the revenue wisely, but it is EWCA's position that a significant share should be allocated to areas where the hunting takes place to create a link between the local communities and the crocodile resource, and to reinforce conservation

behaviour by the community members at the local level. The SNNPRS has now passed a new regulation on how to distribute the income from the sector (e.g., gate fees, hunting income, etc...), the main elements of which are:

- Principally 60% should be directly used for local community benefit, though this may be decreased to 20 – 35% in the near future.
- Under this principle, 10 projects have been funded which include awareness campaigns at the zonal and woreda levels, construction and furnishing of museums, purchasing of one motor boat and two grinding mills, construction of residences for teachers and health posts, and afforestation programs.
- A share of the income has been used for the improvements of AMCR: construction of the 3rd year crocodile ponds, construction of a modern slaughterhouse, and purchase of equipment and storage houses for the production of crocodile meat for the local and national markets.

3.2.5. National and International Trade in Live Animals

In 2010, AMCR collected and sold 3000 hatchlings (doubling their harvest that year) from Lake Chamo to establish founder stock for the Blen Development PLC (private ranch also located in Arba Minch). They apparently anticipated that this arrangement would continue annually into the future as the Blen Development PLC ranch has a capacity for 10,000 individuals. Unfortunately, Blen Development PLC is in arrears with the bank, which has repossessed the facility, and its future is uncertain.

This has been the sole instance of trade in live animals to a national receiving body and there are no records of live animals ever being exported internationally as part of the ranching program. However, the export of live hatchlings to other crocodile farming facilities is a strategy that EWCA and SNNPRS should consider for diversifying the AMCR revenue stream. For example, due to a lack of skin sales and the fact that slaughtering is done on demand, there is no space currently at the ranch for new stock and as a result hatchlings were not harvested from the lake in 2014. Trade in live hatchlings to ranches and farms in other countries may ensure that revenue is generated even in years with no skin sales or hatchling harvest for AMCR's own stocks.

3.2.6. Illegal Trade

There is very little information on illegal trade, and very little suspicion that illegal trade is a problem. In 2013, a truck was confiscated trying to cross the border to South Sudan with a small number of crocodile skins (i.e., 3-5). Crocodile skins do not appear to feature regularly in the typical wildlife skin depots in Addis Ababa

(e.g., along Churchill Road). We briefly visited five of these shops under the pretense of being customers looking for wild leather products (not just crocodile) and at all but one were told in no uncertain terms that crocodile skin was unavailable due to its protected status in the country; python skins, however, were readily available. Both the vendors and other customers in the shops at the time also warned that should we succeed in finding crocodile skins they would almost certainly be confiscated at the airport. The one vendor who could get crocodile skins indicated that they were no more than 30 cm total belly width, further supporting the low probability of an illicit trade in wild adult skins. By all accounts, illegal trade seems to be a rare phenomenon and is presently not a concern for the Lake Chamo, or other national, crocodile populations.

None of the vendors along Churchill Road, who also manufacture their own leather goods for sale to tourists, were aware of the availability of legal skins from AMCR for this purpose. This could be a small, but important, market opportunity for the AMCR and we recommend that a marketing and education feasibility study be undertaken for this potential local market. Artisanal leather, and other (e.g., teeth, skulls, etc...), products could be purchased and exported by tourists as personal effects assuming they meet the conditions of Resolution Conf. 13.7 (Rev. CoP16) and Article VII. This could be achieved reasonably simply given the existing ranching program and the Appendix-II status of the Nile crocodile population.

3.2.7. Role and Involvement of Local Communities in Crocodile Management

Currently, local communities have little direct involvement in crocodile management, and crocodiles appear to have either no impact on poverty alleviation or no appreciable negative impact on livelihoods (e.g., fishing, legal or illegal). However, since 2011, local farmers have been clearing and developing fields for maize production, often down to the lakeshore in known crocodile nesting beach areas. Approximately 64 households sprang up as a result. In 2012, the SNNPRS administration recognized this issue as a specific threat to the crocodile resource and encouraged the Gamo Gofa zonal administration (including the Tourism Bureau, Arba Minch City Administration, and AMCR) to find a solution. The proposed solution was to relocate the farmers and provide them with legal tenure in new lands. AMCR specifically cooperated in the outreach and education programs concerning the benefits crocodile nesting sites provide through hatchling production, and the threats to these benefits that agricultural encroachment represented. The farmers found the solution acceptable. The previous use of the land was illegal and involved conflict with crocodiles (particularly predation on livestock), whereas the new arrangement gave them legal land without crocodiles.

Other than this, the only significant involvement of the local communities is through an existing outreach and awareness program. This is conducted both through AMCR and the local city and zonal administration. The efforts are both directed special projects focused on crocodile outreach and through the normal zonal administration outreach efforts to ensure local communities living in more

rural zones are aware of the legal and administrative frameworks. These efforts have met with some success. One nesting beach had well over 30 nests adjacent to, and even within, a local maize plantation. The local farmers said that they did not destroy the nests or fear the crocodiles and were even quite happy to have them nesting in their field despite the fact that at least several maize stalks were dug up by nesting females. The local farmer specifically referenced the outreach program and annual conversations with the AMCR scouts while they were nest guarding in previous years as some of the main reasons why they developed an appreciation and respect for the crocodiles. In all cases here, either removing people from crocodile areas or winning support for more tolerance has alleviated the impact of people on crocodiles. Neither involves wealth generation as a consequence of the crocodiles, as would be the case if the maize farmers got \$1 for each egg produced on the nesting bank, for example.

3.2.8. Quota Setting for Arba Minch Crocodile Ranch

We were made to understand that since 2007 the quota is meant to be 3,000 hatchlings per year, but in 2010 as many as 6,500 hatchlings may have been harvested to supply both AMCR and the Blen Development PLC private ranch. In most other years the number harvested ranged between 3,000 and 4,000 hatchlings.

Since 2007, the annual hatchling harvest quota has been loosely based on the recommendations by Whitaker (2007), which suggested some 10,000 hatchlings could be harvested annually from Lake Chamo. Based on this, the SNNPRS and AMCR administrations assumed that a quota of less than 10,000 would be conservative and safe, while matching the space capacity of 9,000 individuals at AMCR. Unfortunately, Whitaker's (2007) more important suggestion – that the harvest quota should be based on annual nesting surveys – was not implemented by the SNNPRS (or at least no data was made available to us supporting implementation of nest harvest strategies).

In the intervening 7 years, decreased protection of the crocodile resource (animals and nests), increased water levels possibly inundating nest sites, and reduced habitat management reducing nest site availability, may all have occurred. Regular nesting census surveys provide an index of whether the adult nesting female population is increasing, decreasing or stable over time (notwithstanding annual variation in the percentage of females that nest each year, which may be linked to environmental factors). It may well be that a 10,000 hatchling ceiling on the hatchling harvests will prove totally sustainable, but if not, the harvests could be scaled to nest (adult female) abundance and/or egg availability.

There is no input on the annual quota from EWCA because national policy relegates all responsibility and decision-making for ranching to the Regional administration. In practice, the quota is not a scientifically derived figure, but rather the ranch manager sets a number of hatchlings collected to match available space and budget for food and medication resources, and that is well below the ceiling of

10,000 recommended by Whitaker (2007). So the quota is more of a conservative reduced harvest ceiling, and as such, is apparently not subject to oversight or approval at the state or federal level.

Annual harvest levels have no bearing on the annual export quotas set by EWCA as part of Ethiopia's Appendix-II listing. There is nothing wrong with harvesting within what is considered a conservative hatchling harvest ceiling, even if it is called a "quota," but clear protocols about how and why the annual quota within that ceiling is increased, decreased or kept stable need to be derived, and nest monitoring programs introduced as an independent mechanism for adapting the harvest (if need be) and fulfilling the non-detriment obligations of Appendix II.

3.3. Reporting and Monitoring

It was clear to the review mission that reporting and monitoring had both declined precipitously over time. Scattered population survey data and reports conducted by EWCA and SNNPRS were largely available, although they were infrequent and seemed in breach of the national regulations that stipulate, at least, biennial surveys for trophy hunting (which has now ceased) and annual surveys as part of the ranching harvest program (which continues, but at a much lower level than originally envisaged). AMCR records on farm production generally were virtually non-existent.

As a consequence, EWCA appears to have had difficulty complying with the annual reporting provisions of their ranching program with the CITES Secretariat. Typically, the reports should summarize the status of both the wild population and farm/ranch performance (current stock, mortality rates, etc...). It is recommended that, as part of their annual permitting process, the AMCR should be required to submit standardized quarterly stock returns [e.g., numbers of hatchlings, raising stock (perhaps in 2 size classes), adult stock (if any), etc...], including the extent of the annual hatchling harvest, mortality rates, and skin sales. This would facilitate EWCA's reporting obligations to CITES, and would be a positive step towards a new business plan for AMCR.

3.3.1. Raising

While very little specific data was available in this regard, AMCR is structured with size-relevant cohorts housed together and rotated through the facility to minimize size-related competition for food and space. No data on growth or the transfer of stock between cohorts seems to be available after 1999.

3.3.2. Culling

Individuals within AMCR are only culled when orders for skins are placed. In this way, AMCR can custom cull individuals to meet the size requirements of the order and does not have to worry about the long-term integrity, storage and preservation of unsold skin stocks. It was not very clear to us how or where animals were

slaughtered and skinned in the past, but AMCR is currently finishing construction of its own on-site abattoir for all future slaughtering, skinning and meat preparation.

3.3.3. Exports

Table 1. Ethiopian Nile crocodile quotas and actual exports/take, 2000-2013.

| Year | Ethiopian Year | Ranched Skins Quota | Ranched Skins Exported ¹ | Hunting Trophies Quota | Hunting Trophies Taken ² | Confiscated Skins ³ |
|-----------|----------------|---------------------|-------------------------------------|------------------------|-------------------------------------|--------------------------------|
| 2000/2001 | 1994 | 3500 | 0 | 16 | 1 | 0 |
| 2001/2002 | 1995 | 5000 | 0 | 17 | 8 | 0 |
| 2002/2003 | 1996 | 5000 | 900 | 13 | 6 | 0 |
| 2003/2004 | 1997 | 4500 | 300 | 11 | 4 | 134 |
| 2004/2005 | 1998 | 6000 | 347 | 10 | 5 | 134 |
| 2005/2006 | 1999 | 3000 | 727 | 10 | 8 | 134 |
| 2006/2007 | 2000 | 3000 | 594 | 3 | 2 | 134 |
| 2007/2008 | 2001 | 3000 | 492 | 3 | 0 | 0 |
| 2008/2009 | 2002 | 3000 | 0 | 2 | 0 | 0 |
| 2009/2010 | 2003 | 0 | 4 | 2 | 0 | 0 |
| 2010/2011 | 2004 | 2000 | 0 | 0 | 0 | 0 |
| 2011/2012 | 2005 | 2000 | 0 | 2 | 0 | 0 |
| 2012/2013 | 2006 | 3000 | 0 | 2 | 0 | 3-5 |

¹Data taken from the UNEP-WCMC species trade database.

²Figures for 2000 – 2004 available from EWCA and not exclusive to Lake Chamo. Figures from 2005 – 2007 taken from Roussos and Roussos (2007).

³It is highly unlikely that exactly 134 skins were confiscated 4 years in a row, most likely representing an error in record keeping.

3.4. Law Enforcement and Implementation

3.4.1. Local

Law enforcement activities in the Nechsar NP area, and elsewhere in Lake Chamo, also appear to have declined over time. Fishing is forbidden in the park, but seems difficult to enforce. We observed over 300 individual fishing nets in the lake, with about a third located in the park. For the open lake areas, there are regulations as to the type and size of nets that can be used, but this does not seem to be enforced by the local fisheries administration. We support the recommendation by Whitaker (2007) that EWCA should more actively enforce the fishing regulations in the national park, and work more closely with the local fisheries authorities to improve regulation of the fishing industry in non-park areas of the lake. Any CHAs that are designated should, additionally, include management provisions to support fisheries-related law enforcement efforts.

3.4.2. National

The enforcement of wildlife laws at the national level is the responsibility of the Wildlife and Wildlife Products Trafficking Directorate of EWCA in collaboration with law enforcement authorities (e.g. police, security, customs) throughout the country. There is presently good coordination of wildlife law enforcement efforts between the different agencies and great improvements have been made to curb illegal trade. Efforts are presently concentrated on ivory, but the systems established can easily be applied to other species and products, including crocodile skins. As discussed in Section 3.2.6, there appears to be little illegal trade in crocodile products at the national level and, further, information provided by informants in Addis Ababa suggests that people are aware of the protected status of the crocodile resource both at the shops along Churchill Road, but also at the airport and other points of export.

3.4.3. International

There have been coordination meetings between EWCA, customs, and police authorities to inform the “front line” officers at customs points and the airport on how to detect and identify illegal wildlife products, especially ivory. Should crocodile products become a problem, these established cooperation procedures are in place. With regard to the CITES obligation to inspect crocodile skin exports, it appears EWCA officials rely mainly on the information reported by AMCR and the exporter, instead of physically inspecting skin shipments to verify that skins of wild origin are not being exported with ranched skins. The major concern is the potential for large adult skins to be exported amongst ranched skins, and efforts to detect obviously oversized skins would mitigate this as an issue.

3.5. Wild Species Issues

3.5.1. Species Distribution (Historical and Contemporary) and Identification of Key Areas (e.g. nesting and nursery)

There is very little historical information on the distribution of Nile crocodiles in Lake Chamo, though crocodiles are generally distributed throughout the lake and there are no obvious habitat, or management, features suggesting this shouldn't have always been the case. Changes in occupied areas will be difficult to assess because few surveys documented specific locations of crocodile sightings or relevant survey data (e.g., start and stop points for transects). Two AMCR scouts, who have been working at AMCR for 23 and 26 years respectively, related the following:

The trend in crocodile abundance and nesting ground availability appears to be decreasing after 2008, before which it seemed to be at a good level and stable. The period during which African Parks managed Nechisar NP seemed to be the best management situation and time period for the crocodiles, but since then they noticed changes in fishing, including newly introduced seine nets used close to

shore for tilapia, as well as increased fishing throughout, but especially in the park.

Since 2008, there appears to be an increase in fishermen and camps destroying crocodile nests and resulting in nest site abandonment by crocodiles. Conflict with nets, livestock and people are creating bad attitudes - resulting in people killing crocodiles by shooting and with spears.

There appears to have been an increase in water volume and general lake level, but this increased water level does not seem to flood nesting sites as it is largely expanded into a large floodplain in the south of the lake. The 1-4-year-old crocodiles (meaning individuals less than 2 m) likely hide themselves from the big crocodiles in the vegetated areas, small streams, etc., that have become more abundant with the increased water levels.

Most of the nesting sites are known historically and are referenced by a local name (see Whitaker 2007). For the most part, the same nest sites have been managed by AMCR since the mid-1980s up until 2011 when two key sites were lost to agriculture and fishing camps, and around 2009 the crocodiles seemed to have shifted from one site (Bole) to another (Sago).

3.5.2. Biological Status



Fig. 2 Review Mission Day (left) and Night (right) Survey Effort of Lake Chamo. Tracks (yellow and blue lines, respectively) are visualized on Google Earth satellite imagery of Lake Chamo.

From 1-3 May 2014 we conducted two diurnal and three nocturnal crocodile surveys following standard spotlight survey protocols (e.g., Shirley *et al.* 2009; Webb and Smith 1987). Counts were conducted from a 7 m metal “tourist cruising” style boat provided by EWCA with a 40 hp outboard motor moving 9-12 km/h following along the shore at an average distance of 50-100 m depending on vegetation and submerged rocks. Crocodiles were detected with the assistance of 10 x 42 binoculars during the day and both a 100,000/200,000 cp flood/spotlight and a 1-watt LED headlamp at night. Crocodiles were typically detected and classed demographically by a single observer, though secondary observers participated as a means of training and counting nets. Detected crocodiles were approached and their

size estimated where possible. Unapproachable individuals (i.e., due to shallow water or dense aquatic vegetation) were classified as “eyes only” (EO). Additional data were collected on anthropogenic threats to crocodiles throughout the surveys (e.g., nets and other fishing devices).

We surveyed \pm 40% and 70% of Lake Chamo during day and night surveys, respectively (Fig. 2). Unforeseen logistical hurdles (e.g., fuel shortages in Arba Minch) and inclement weather limited our diurnal survey efforts and more or less confounded both surveys on the third day. Our day surveys were consistently confounded by high winds, were exclusively conducted during the late afternoons due to logistical constraints (i.e., we left Arba Minch at midday to conduct the day survey outbound and the night survey on the return), and did not include the famous “Crocodile Market” (where normally around 60 sub-adult and adult crocodiles were observed, ranging from 1.5 – >4.5 m TL, during 3 casual visits). Thus, diurnal census results are not easily compared with previous efforts.

Regardless, our daylight surveys only detected about 15% of the number of crocodiles seen by Whitaker in 2007. Though when scaled to the reduced area of lake we surveyed, this was probably closer to 40%. We believe that this discrepancy was largely due to survey visibility bias caused by the particularly windy conditions during our surveys (i.e., because crocodile submergence increases with increasing wind and waves). Because of this, no further discussion will be based on our daytime survey results.

During the night surveys, we counted approximately 400 non-hatchling crocodiles over 70% of the lake shoreline, giving a crude total shoreline estimate of about 571 individuals. Whitaker (2007) surveyed 100% of the shoreline and recorded 541 crocodiles. Once-off census counts, such as those currently available for Lake Chamo, are typically unable to provide robust estimates of true crocodile abundance owing to issues of crocodile detectability. For example, previous studies have estimated that only 0.0 – 65.0% of crocodiles may be at the surface and available to be counted depending on population and survey-specific variables (Bayliss 1987; Grigg *et al.* 1985; Hutton and Woolhouse 1989; Pacheco 1996a, 1996b; Seebacher *et al.* 2005; Shirley *et al.* 2012; Woodward *et al.* 1996; Woodward and Marion 1978). In addition, crocodile detectability decreases in areas of extensive aquatic or lakeshore vegetation. In light of these detectability issues, the absolute number of crocodiles in Lake Chamo is appreciably greater than the numbers counted by Whitaker (2007) or us, and it is clear that Lake Chamo supports a large and healthy crocodile population (Table 2).

Table 2. Survey Characteristics for 2014 CSG Review Mission Crocodile Surveys on Lake Chamo.

| Date | Day or Night | Survey Length (km) | Nesting Sites | Nets | Camps/Villages | Hippos |
|--------------|--------------|--------------------|---------------|------------|----------------|-----------|
| 1-May-14 | Day | 27.0 | 0 | 170 | 20 | 63 |
| 3-May-14 | Day | 13.1 | 1 | 40 | 4 | 21 |
| Total | | 40.1 | 1 | 210 | 24 | 84 |
| 1-May-14 | Night | 31.4 | 1 | - | - | - |
| 2-May-14 | Night | 23.6 | 2 | 100 | 5 | 3 |
| 3-May-14 | Night | 11.9 | - | 9 | 2 | - |
| Total | | 66.9 | 3 | 109 | 7 | 3 |

Table 3. Survey Results for the 2014 CSG Review Mission Crocodile Surveys of Lake Chamo. H is the hatchling demographic, which we roughly estimated for encountered hatched nests. Y is the “yearling” demographic, representing animals between 0.45 – 0.8m TL. The >2, etc... categories are sightings of confirmed adults whose precise size could not be estimated more precisely than above a certain TL. Encounter Rate is the number of crocodiles encountered per km of survey, while Adjusted Encounter Rate removes the H and Y demographics from that calculation.

| Date | Day or Night | Survey Length (km) | Size Class | | | | | | | | | | | | | | | | | Total | Total (No H) | Encounter Rate | Adjusted Encounter Rate |
|--------------|--------------|--------------------|-------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|----------|-----------|----------|----------|------------|-------------|--------------|----------------|-------------------------|
| | | | H | Y | < 1.0 | 1.1 - 1.5 | 1.5 - 2.0 | 2.0 - 2.5 | 2.5 - 3.0 | 3.0 - 3.5 | 3.5 - 4.0 | 4.0 - 4.5 | 4.5 - 5.0 | >2 | >3 | >4 | >4.5 | >5 | EO | | | | |
| 1-May | Day | 27.0 | | | | | | 1 | 1 | | 3 | | | 6 | 8 | 13 | 5 | 1 | | 38 | 38 | 1.407 | 1.407 |
| 3-May | Day | 13.1 | | | | 1 | 1 | 1 | 1 | | 6 | 1 | | | | 2 | 1 | | 1 | 15 | 15 | 1.145 | 1.145 |
| Total | | | 0 | 0 | 0 | 1 | 1 | 2 | 2 | 0 | 9 | 1 | 0 | 6 | 8 | 15 | 6 | 1 | 1 | 53 | 53 | 1.276 | 1.276 |
| 1-May | Night | 31.4 | 1000 | 25 | 2 | 11 | 6 | 10 | 8 | 3 | 8 | | | 25 | 2 | 3 | | | 79 | 1182 | 182 | 37.643 | 5.796 |
| 2-May | Night | 23.6 | 40 | 29 | 7 | 15 | 4 | 3 | 2 | 2 | 6 | 3 | | 1 | | 1 | 2 | | 79 | 194 | 154 | 8.220 | 6.525 |
| 3-May | Night | 11.9 | | 9 | 1 | 2 | 1 | 1 | 2 | 2 | 1 | | | | 1 | 1 | | | 46 | 67 | 67 | 5.630 | 5.630 |
| Total | | | 1040 | 63 | 10 | 28 | 11 | 14 | 12 | 7 | 15 | 3 | 0 | 26 | 3 | 5 | 2 | 0 | 204 | 1443 | 403 | 17.165 | 5.984 |

Table 4. CSG Review Mission Nocturnal Survey Results by Lake Chamo Zone. Proportion represents the percentage of sightings that fell within each zone, day counts show the number of crocodiles counted in each zone during days surveys, correction factor is the number of crocodile seen during the day divided by the number seen at night in each zone.

| Zone | Shore line (km) | Size Class | | | | | | | Total | Proportion | Day Counts | Correction Factor | 2007 Night Survey | 2007 Proportion |
|--------------|-----------------|------------|-----------|-----------|-----------|-----------|----------|------------|------------|------------|------------|-------------------|-------------------|-----------------|
| | | <1.0 | 1.0 - 2.0 | 2.0 - 3.0 | 3.0 - 4.0 | 4.0 - 5.0 | >5.0 | EO | | | | | | |
| 1 | 8.9 | - | - | - | - | - | - | - | 0 | 0.0% | 0 | 0.00 | 85 | 15.7% |
| 2 | 10.4 | 4 | 1 | - | - | - | - | 28 | 33 | 8.3% | 0 | 0.00 | 98 | 18.1% |
| 3 | 14.5 | 26 | 21 | 2 | 3 | - | - | 43 | 95 | 23.9% | 0 | 0.00 | 30 | 5.5% |
| 4 | 4.7 | 1 | 4 | 3 | 5 | 6 | - | 8 | 27 | 6.8% | 7 | 3.86 | 23 | 4.3% |
| 5 | 14.1 | 9 | 3 | 2 | 4 | 1 | - | 42 | 61 | 15.3% | 21 | 2.90 | 42 | 7.8% |
| 6 | 19 | - | - | - | - | - | - | - | 0 | 0.0% | 0 | 0.00 | 33 | 6.1% |
| 7 | 10.9 | 19 | 8 | 10 | 6 | 1 | - | 21 | 65 | 16.3% | 4 | 16.25 | 78 | 14.4% |
| 8 | 21.8 | 10 | 5 | 22 | 20 | 2 | - | 58 | 117 | 29.4% | 21 | 5.57 | 152 | 28.1% |
| Total | | 69 | 42 | 39 | 38 | 10 | 0 | 200 | 398 | | 53 | | 541 | |

In contrast to the relatively congruent total count numbers, our nighttime survey results deviated from Whitaker's (2007) in terms of crocodile population size structure. This is commonplace in repeated spotlight counts of the same area by completely different survey teams (Webb *et al.* 1989), with one of the major biases being the confidence with which surveyors estimate size classes, and often resulting in different proportions of "eyes only" sightings. The problem may be compounded by the fraction of "eyes only" sightings being heavily biased towards larger crocodiles (Webb *et al.* 1989). Though in areas with significant vegetation, shallow water, and other features limiting approach distance, "eyes only" sightings can be more evenly comprised of other demographics, which is likely the case for our survey of Lake Chamo.

Whitaker (2007) sighted 65 "very large" crocodiles (i.e. >4.5 m TL; all males), which equated to 12.0% of all crocodiles sighted ($n = 541$; Whitaker does not indicate that any of his sightings are "eyes only"). We classified ± 17 "very large" crocodiles, which equated to 3.0% of all crocodiles sighted ($n = 571$), and 8.5% of the crocodiles for which size estimates were made ($n = 199$; 49.4%). The largest source of discrepancy in this result is the fact that our night surveys did not include the "Crocodile Market" – the single site with the largest concentration of large crocodiles in Lake Chamo. The other largest source of the discrepancy in this result is the much larger number of "eyes only" classifications recorded by us. As indicated above, Webb *et al.* (1989) found that a large proportion of "eyes only" sightings can be attributed to large crocodiles; however, this mostly applies to situations where sightings are "eyes only" due to crocodile submergence upon detection before classification. While many of our "eyes only" sightings were certainly large adults that submerged before we could approach for classification, many were simply unapproachable because the crocodile was deep in vegetation or in a shallow/rocky area. In summary, given the discrepancies in survey coverage and "eyes only" classifications, differences in the 2007 and 2014 surveys may not suggest a decrease in "very large" crocodile abundance.

In contrast, the 2007 night survey reported 5.0% ($n = 27$) of all crocodiles sighted were <1.5 m TL, whereas we recorded 100 individuals (17.5%) in this size class. This count is certainly an underestimation owing to the number of unclassifiable "eyes only" sightings that were likely juveniles in unapproachable areas of vegetation. In addition, we did not survey zone 6, which contains the most inundated vegetation habitat, which is ideal as a juvenile crocodile nursery. There are several possible explanations for this increase in juvenile crocodiles, the most likely being an anecdotal report of rise in overall lake water level, resulting in an increase in inundated vegetation habitat. For example, in many places the plot of our GPS track log shows us driving over what was land when the satellite image in Google Earth was taken in 2004. Our results confirm that recruitment is continuing in the population, and assuage concerns expressed by Whitaker (2007) over juveniles being a largely missing demographic.

To remain consistent with previous efforts we also counted hippos during our day surveys. Our survey count of 80 hippos is 60% more than the Gebre and Shifeta (2010) survey and congruent with the Whitaker (2007) survey. These numbers suggest that the Lake Chamo hippo population is healthy and one of us (LS) feels that a hippo trophy-hunting quota could be envisaged, especially for the areas where agriculture reaches the lakeshore and there is the potential for human-hippo conflict. While we did not hear any rumors about hippo poaching as reported by Whitaker (2007), we also did not specifically investigate this issue.

3.5.3. Monitoring - Types and Methods

Since the 1970's there have been a series of one-off surveys [referenced in Whitaker (2007)], the last of which was Whitaker (2007), upon which various management actions are based today. For example, Whitaker (2007) recommended closing the trophy hunting and AMCR established the $\pm 3,000$ hatchling annual harvest based on the 10,000 hatchling ceiling estimated by Whitaker (2007).

We found that most surveys to date were faced with methodological issues, as well as erroneous assumptions about the relationship between the proportion of crocodiles sighted during day versus night counts and the relationship between the corrected day counts and absolute abundance (i.e., the real number of crocodiles present). All of these issues may result in wide abundance estimation errors, ultimately confounding management recommendations.

Currently, surveys are conducted during the day only (although specific times are unavailable in most reports) and they cover the full lakeshore, following the procedure outlined by Bolton (1984). It is unclear how many observers are usually counting crocodiles but the results (i.e., relative abundance from day counts) are usually converted to a spotlight count equivalent (i.e., approximating relative abundance from spotlight counts) by a fixed correction factor of 1.8 for the total count. This correction does not consider differences in detection amongst size classes (e.g., the likelihood that a much smaller proportion of juveniles are detected during the day). Most reports include statements about changes in population size since the last survey (usually 3-5 years previous) based on these corrected daytime counts. It seems likely that there are significant errors and biases introduced by this protocol, as follows.

The last four surveys were conducted at different times of the year (i.e., May 2014, December 2010, January 2007, February 2004), despite the probability of sighting crocodiles in a survey being affected by season (e.g., changing temperature profiles impacting basking, start of the nesting season, changes in water level impacting distribution, etc...). Indeed, seasonal movements of crocodiles between Lake Chamo and Lake Abaya may also contribute. Over and above this, daytime surveys are biased towards larger crocodiles, which can be more easily seen, relative to spotlight surveys during which all size classes are typically detected.

The use of a single correction factor (1.8) is clearly problematic. First, this correction factor can vary considerably over time. As an example, the ratio of day to night detections during our surveys was an average 7.6, and ranged from 2.9 to 16.3 in different zones. Poor weather during our day surveys may have contributed to this, but clearly there is a great deal of variability. Second, the relationship between day and night counts is such that only *more* crocodiles are detected at night; but night counts themselves are just another index of relative abundance, and would also need to be corrected if the real size of the population (absolute abundance) is needed. Instead of worrying about correction factors, we recommend that a standardized survey protocol is adapted that allows for the detection of changes in the population over time. Not doing so will severely constrain management decision-making and entail considerable risk to the population.

Although the survey methodology should be matched to the exact question that the survey program is expected to answer, we strongly recommend that annual surveys be conducted, using a fixed and standardized methodology, at the same time of year, and ideally using the same personnel to both count crocodiles and estimate their sizes. Night counts, if possible, will always include a higher proportion of the total population, and of each size class within it, than day counts. A comparison of day and night counts, in which size is estimated, may be sufficient to establish indicators of the size structure of animals contained within the “eyes only” component of night surveys, and to establish the extent to which day counts can provide answers to the questions posed. But, given funding and other resource limitations, conducting both day and night counts may not be important.

3.5.4. Presence of *Crocodylus suchus*

Recent molecular studies investigating the systematics of the Nile crocodile indicated that there are actually two, highly divergent species in Africa. All populations of Nile crocodile in West Africa represent a highly divergent species *C. suchus* in relation to the Nile crocodile *C. niloticus* from the rest of Africa (Hekkala *et al.* 2011). Given the newly recognized *C. suchus* (and the current IUCN Red List assessment dating from 1996), the CSG (which is currently revising all crocodilian species) will likely list *C. suchus* as “Vulnerable” or possibly “Endangered” in the near future. Because of this, there is a need to better understand its continental distribution. Contemporary records exist for this species in the Kidepo Valley of Uganda and historical records from museum specimens collected in Sudan are also *C. suchus* (Hekkala *et al.* 2011). Unfortunately, there was not time to evaluate the potential presence of this species in Ethiopia during this review mission, but photographs of animals from the Awash River drainage (Fig. 3) show some morphological characters consistent with *C. suchus*. We highly recommend that an effort be made to confirm the species identification of this population, in light of these recent taxonomic revisions, because if two species are present within Ethiopia it may impact on crocodile utilization schemes introduced across the country.



Fig. 3 Two crocodiles photographed at Awash National Park that resemble *Crocodylus suchus*. Notable amongst the features are the diagonal stripe across the shoulder and the relatively “flatter” and more rugose appearing skull compared to *C. niloticus*. (Photos: L. Siege)

3.6. Captive Species Issues

3.6.1. Historical Context

In 1983 the Ethiopian Ministry of Agriculture, under agreement with the FAO, established a crocodile management program based upon ranching, with a particular focus at Lake Chamo. As part of this program the Ethiopian Government built, equipped and staffed a crocodile farm at Arba Minch near Lake Chamo, on the shores of Lake Abaya. The first *C. niloticus* hatchlings were introduced into the farm in 1985.

Ethiopia acceded to CITES in April 1989 and at CoP7 (Lausanne, October 1989) it successfully submitted a proposal seeking to transfer its *C. niloticus* population from Appendix I to Appendix II subject to an export quota. The proposal indicated that trade in crocodile parts and derivatives would be controlled in the short-term by Resolution Conf. 5.21, and in the longer-term by the then Resolution Conf. 3.15 (ranching). Quotas for the period 1989-1991 involved ranched skins, live hatchlings, hunting trophies, live adults and curios from ranching.

At CoP8 (Kyoto, March 1992), Ethiopia submitted a proposal to transfer its *C. niloticus* population from Appendix II (export quota) to Appendix II pursuant to Resolution Conf. 3.15 on ranching. The proposal was adopted under the condition that no more than 4500 specimens were to be exported before 11 June 1992 (note - this was a reduction from the 6000 quota previously adopted at CoP7). Between 1992 and 2007, legal international trade in *C. niloticus* was confined to ranched skins and a limited number of trophies.

3.6.2. Captive Breeding

There are two captive crocodile facilities in Ethiopia - the Arba Minch Crocodile Ranch (government) and the Blen Development PLC (private). Both facilities are based on *ranching*, with wild hatchlings being harvested from Lake Chamo. AMCR has a pair of adult crocodiles on display that have only nested a single time, but apparently the male cannibalized all the hatchlings. There is no other record of captive breeding in Ethiopia.

3.6.3. Incubation

The ranching program, while technically based on a “hatchling harvest,” is in practice egg harvest with field incubation. Over a 4-5 day period in December, AMCR scouts reportedly conduct day and night surveys of the entire lakeshore to identifying areas where crocodiles bask in large congregations (potential nesting sites) and the presence of people and fishing activities. The scouts use the terminology “census” (counting crocodiles) and “survey” (identifying the critical areas), and the results are discussed in relation to the 8 identified zones. The zones are only used for comparison purposes (mostly intra-zone on an annual basis), and

have no real bearing on the actual harvest except that certain zones are traditionally known as nesting areas. The counts are reported annually to the AMCR manager, but the status of past records is unclear: no such records were found or made available to us, not even from the previous census year.

AMCR scouts identify 4-5 target sites with large congregations of basking crocodiles, which are assumed to represent areas with concentrations of nesting females, and they clear the grass and herbaceous material from the beaches. The scouts return to the sites starting 30 December, establish a camp about 25 m away from the beach, and wait for females to nest. Nesting starts in late December and peaks in January. For each female they observe nesting, they wait until she finishes and insert a stick into the nest as a marker. Any nest that is “too far” from the main tent site (say within 1 km) they collect and deposit the eggs in a new, artificial nest, near the campsite. The campsites are manned by teams of 4 people, one person to guard the main site next to the tent and other three to go and seek out further nests. After all the nests are laid, the team drops to 2-3 people per site to guard nests 24 hours per day, until hatching.

During their nest protection period, the adult females are also still present and actively guarding their nests. The scouts claim that predators, mostly Nile monitors (*Varanus niloticus*), visit the nesting beaches at such a high frequency during the day that there must always be someone on guard. Nocturnal predators include honey badgers and hyenas, though nocturnal predation is less frequent. The scouts claim to have a 90-100% success rate in protecting nests from predators, but the data substantiating this was not available for examination. The AMCR expert, Ehit Bekele, is currently conducting MSc research to quantify the true reduction in nest predation. But assuming the scout estimate is accurate, the Lake Chamo field incubation and ranching harvest truly exemplify the biological basis for ranching programs (i.e., that ranches pretty much only harvest individuals that would never contribute to recruitment under natural circumstances due to, for example, high rates of nest predation by varanids) and is very likely sustainable.

Hatchlings from all identified nests guarded during the incubation are harvested by the AMCR scouts, including any from nests that were previously unidentified. Hatchlings that exceed the established quota are released into the water by the scouts, or protected until the female comes and collects them from the nest cavity. The protection team at each harvest site each keeps records on the number of nests and the number of eggs in transferred nests. Once the hatchlings start to emerge, these reports are used to estimate how many hatchlings should be harvested from each of the nesting sites. The hatchlings are kept at the campsite in a specially constructed box for 1-3 days until the AMCR boat collects them.

This harvest strategy, while unusual amongst global crocodile ranching programs, is suited to the financial and technical resources of the AMCR (e.g., funds, expertise, and infrastructure may not be available for successful artificial incubation at the AMCR). In addition, it provides the additional benefit of having government

officers present on the lake and interacting with local fishermen and farmers for informal education and outreach during the crocodile breeding season.

One of the drawbacks to this field incubation protocol is the seemingly high hatchling mortality. Each holding box at the campsites contains 50 hatchlings, from which 3-10 hatchlings per box (6-20%) will die before transfer to the ranch. It is uncertain why there is mortality between hatching and arrival at AMCR, and whether this reflects natural mortality (e.g., large yolks, premature hatching, etc...) or inadequate holding conditions (e.g., poor ventilation or access to drinking water in the boxes). In the case of the former, the AMCR scouts could simply minimize manually opening eggs until the majority of eggs in any given nest have hatched naturally or they could simply only selectively harvest “normal looking” hatchlings. For the latter, the AMCR could consider modifying the design of the hatchling boxes or simply transport hatchlings to the ranch sooner and/or more frequently.

3.6.4. Growth Rates

Meticulous notes on growth and all other aspects of the raising of ranched hatchlings in captivity are available until about 2000. Since then, record keeping and reporting has diminished dramatically. The manager of the AMCR indicated a renewed commitment to record keeping has occurred since 2010, but we were unable to confirm. The AMCR staff’s verbal description of mortality rates from the hatchling to the 1-year old stage suggests it is “low” and within normal expectations (e.g., 10%).

The hatchlings and 1-year olds are kept in a greenhouse that relies on the sun and greenhouse thermodynamics for heat. However, the current state of disrepair of the greenhouse (Fig. 4) may contribute to mortality by not be efficiently retaining the heat and humidity needed for optimal growth, nor providing protection from predators such as raptors and mesocarnivores. We recommend that the greenhouse facility be repaired and upgraded as soon as possible.

3.6.5. Mortality

Meticulous notes on this, and all other aspects of the captive population management are available until about 2000, since that time the regularity and detail of records has decreased dramatically. The 2011 AMCR report to CITES on the two ranches in Arba Minch suggested that AMCR had incredibly high mortality rates in 2004 (80% of 7-year-olds) and 2007-2009 (30-60% of 2-4-year-olds). Since then, mortality seems to have come under control, but we were unable to verify this with primary data before or after 2010. The Blen Development PLC ranch had 30-41% mortality of 1-3-year-old crocodiles in 2008-2010. Since then, the bank repossessed the ranch and current mortality levels are unknown.

The lack of records, in either paper or electronic form, hampers objective assessment of the ranching programs, and should be rectified in order to comply with the CITES reporting obligations linked to ranching.

3.6.6. Husbandry Assessment (including Food Supply)

As for most crocodilian ranching and farming operations globally, food supply is the single largest concern for the reliable growth and sustainability of the crocodile product. The biggest deficiency at AMCR appears to be access to food that, until 2010, came mostly in the form of free offal from local abattoirs, but is now purchased due to the competition for the resource introduced by the Blen Development PLC ranch. This has resulted in occasional food supply gaps and slowed growth rates for crocodiles.



Fig. 4 Hatchling grow-out facility (left) and hatchlings (right). The greenhouse is in need of repair to ensure both protection of hatchlings from predators and optimal growth temperatures. Despite its condition, however, the hatchlings all appeared to be in good physical condition.



Fig. 5 Grow-out facility for 2 and 3 year-old and older individuals. Note the adequate access to shade, clean water, and the smoothed concrete floor, all of which are cleaned nearly daily.



Fig. 6 Two 4+ year old crocodiles pulled at random from the grow-out facility for inspection of belly skin quality. The skins are not perfect, but do not show any large abrasions, signs of infection, or parasites. All indications are that the AMCR can produce high grade skins.

Beyond this, the crocodile husbandry actually appears to be high quality. There were very few individuals that appeared to be compromised by bad husbandry (e.g., growth defects, bone deformities, injuries, failing to thrive, etc...). The water is changed regularly, often on a daily basis, and the facility did not have any lingering odor. The facility for individuals >2 years of age provides adequate access to sun and shade, as well as fresh water and space for conflict avoidance. The facility floor is highly smoothed concrete and none of the examined individuals showed signs of swollen or abraded feet, or erosion of the belly skin or skin around the mandible (Figs. 4 – 6).

3.7. Capacity Assessment and Training

One of the aims of the review mission was to assess, to the extent possible, Ethiopian capacity for crocodile monitoring and management. This was largely done through interview, observation and assessment of the participation of Ethiopian personnel in our activities. Generally speaking, we found that personnel involved with the wild populations were highly competent at detecting and demographically classifying crocodiles, especially considering that most people with whom we worked had not previously conducted crocodile surveys. One notable exception to this were the EWCA Nechsar NP boat drivers who were clearly not accustomed to going out on the lake at night, something they could overcome with experience and training.

The staff at AMCR, despite budgetary limitations, maintained the crocodiles and facilities in good working order. The staff captured a few crocodiles for us in a safe and professional manner, demonstrating their comfort and competence with the animals. Maintaining institutional memory is clearly important to AMCR but conflicts with the rapid turnover rate of EWCA and SNNPRS experts in the absence of extensive record keeping. The AMCR director, Dr. Tigist, was a knowledgeable and competent individual who could take AMCR to new levels with training in the business management of animal production and/or if provided with a business manager with experience managing poultry, dairy, or

other animal production operations – as opposed to another wildlife biologist or veterinarian.

There is significant capacity and competence in country to properly manage and monitor the crocodile resource, as well as train the next generation to ensure its long-term success and sustainability.

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