Trinational Trade and Enforcement Training Workshop to

Support the Legal and Sustainable Trade in Turtles and Tortoises

Commission for Environmental Cooperation – August 2019

Please cite as:

CEC. 2019. *Trinational Trade and Enforcement Training Workshop to Support the Legal and Sustainable Trade in Turtles and Tortoises*. Report. Montreal, Canada: Commission for Environmental Cooperation. 2019. 84 pp.

This publication was prepared by Kurt A. Buhlmann, Michael J. Dreslik, and Peter Paul van Dijk for the Secretariat of the Commission for Environmental Cooperation. The information contained herein is the responsibility of the author and does not necessarily reflect the views of the CEC or the governments of Canada, Mexico or the United States of America.

About the author(s):
Kurt A. Buhlmann, Ph.D., is a conservation ecologist, focusing on recovery of threatened amphibians and reptiles, and operates Buhlmann Ecological Research and Consulting, LLC, and is also a Senior Research Associate at the University of Georgia's Savannah River Ecology Laboratory.

Michael J. Dreslik, Ph.D., is an ecologist with Applied Envirolytics, LLC.

Peter Paul van Dijk, Ph.D., is Director of Turtle Conservation Programs, with Global Wildlife Conservation; Field Conservation Director at the Turtle Conservancy; and deputy chair of the IUCN SSC Tortoise & Freshwater Turtle Specialist Group.

Reproduction of this document in whole or in part and in any form for educational or non-profit purposes may be made without special permission from the CEC Secretariat, provided acknowledgment of the source is made. The CEC would appreciate receiving a copy of any publication or material that uses this document as a source.

Except where otherwise noted, this work is protected under a Creative Commons Attribution Noncommercial–NoDerivative Works License.

© Commission for Environmental Cooperation, 2019

ISBN: 978-2-89700-275-6

Disponible en français – ISBN: 978-2-89700-277-0

Disponible en español – ISBN: 978-2-89700-276-3

Legal deposit – *Bibliothèque et Archives Nationales du Québec*, 2019
Legal deposit – Library and Archives Canada, 2019

Cover photo : *Glyptemys insculpata* (wood turtle), Kurt A. Buhlmann

Publication Details

Document category: Project publication
Publication date: August, 2019
Original language: English
Review and quality assurance procedures:
Final Party review: June, 2019
QA348
Project: Operational Plan 2017–2018 / *Supporting Sustainable Trade of CITES Species*

Commission for Environmental Cooperation
700 de laGauchetière St. West, Suite 1620
Montreal (Quebec)
H3B 5M2 Canada
t 514.350.4300 f 514.350.4314
info@cec.org / www.cec.org

Table of Contents

Acronyms and Abbreviations v

Abstract vii

Executive Summary viii

Acknowledgements x

Preface xi

1. Introduction 1

2. Background Information 4

3. Conservation Biology Session 9

4. Management and Trade Session 13

5. Law Enforcement Information 28

6. Conclusions and Recommendations from the Workshop 31

Resources 36

Annex A: Workshop Agenda 38

Annex B: Workshop Participants 43

Annex C: Priority Species Summaries 45

Bibliography 61

List of Tables and Figures

Table 1.	Priority turtle and tortoise species	1
Table 2.	Number of turtle species, by IUCN Redlist category	4
Table 3.	Conservation biology session objectives	9
Table 4.	Representative data for life-history traits, summarized for the priority turtle species	11
Table 5.	Management and trade session objectives	13
Table 6.	CITES trade data summary for gross exports of the priority turtle species, 2000–2016	15
Table A1.	Priority species included in the Action Plan for North America on Sustainable Trade in Turtles and Tortoises	38
Figure 1.	A preferred marking scheme for turtles	22

Acronyms and Abbreviations

CA	Canada
CEC	Commission for Environmental Cooperation
CFIA	Canadian Food Inspection Agency
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
Conabio	*Comisión Nacional para el Conocimiento y Uso de la Biodiversidad* (National Commission for the Knowledge and Use of Biodiversity; Mexico)
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
DGVS	*Dirección General de Vida Silvestre* (General Directorate for Wildlife; Mexico)
ECCC	Environment and Climate Change Canada
IUCN	International Union for Conservation of Nature
LEMIS	Law Enforcement Management Information System
LGVS	*Ley General de Vida Silvestre* (General Law of Wildlife; Mexico)
MVP	minimum viable population
MX	Mexico
NDF	non-detriment finding
NGO	nongovernmental organization
NOM-059	Official Mexican Standard NOM059-SEMARNAT-2010 (Mexico)
PARC	Partners in Amphibian and Reptile Conservation (United States)
PIJAC	Pet Industry Joint Advisory Council (United States)
PIT	passive integrated transponder (tag)
Profepa	*Procuraduría Federal de Protección al Ambiente* (Federal Attorney for Environmental Protection; Mexico)
SARA	Species at Risk Act
Semarnat	*Secretaría de Medio Ambiente y Recursos Naturales* (Secretariat of Environment and Natural Resources; Mexico)
SWG	State Wildlife Grant Program, United States Fish and Wildlife Service
SUMA	*Sistema de Unidades de Manejo para la Conservación de la Vida Silvestre* (National System of Management Units for the Conservation of Wildlife; Mexico)
TFTSG	Tortoise and Freshwater Turtle Specialist Group of IUCN
TSA	Turtle Survival Alliance
TTTW	Trinational Turtle Trade Workshop
UMA	*Unidad de Manejo y Aprovechamiento Sustentable* (Wildlife Management and Sustainable Use Unit; Mexico)
UNEP-WCMC	United Nations Environment Programme – World Conservation Monitoring Centre
US	United States
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
WAPPRIITA	Wild Animal and Plant Protection and Regulation of International and Inter-provincial Trade Act
WWF	World Wildlife Fund

Terrapene carolina major (Gulf Coast Box Turtle), Kurt A. Buhlmann

Abstract

The Commission for Environmental Cooperation (CEC) held the Trinational Trade and Enforcement Training Workshop to Support the Legal and Sustainable Trade in Turtles and Tortoises in Miami, Florida, United States, from 24 to 26 October 2018. The development of this workshop was identified as a priority action in the CEC *Action Plan for North America: Sustainable Trade in Turtles and Tortoises* (CEC 2017). The workshop objectives were extensive and sought to understand the ecology and life-history traits of turtles, recognize the challenges presented by trade (both pet and meat trade), identify research and management needs to help achieve sustainable trade and maintain viability of wild populations in North America, develop or revise policy for achieving turtle conservation, and revise a priority-species list.

The topics covered during the workshop addressed conservation, management, and enforcement needs. The workshop was conducted by holding specific sessions focusing on CITES Appendix II species, turtle life-histories, and discussions about non-detriment findings (NDFs), sustainable trade, sustainable harvest, captive breeding (including farming and ranching), and law enforcement. Participants from Canada, Mexico, and the United States sought to explain and understand how each country addressed trade in tortoises and freshwater turtles, in the context of CITES, with the overall goal of increasing trinational cooperation to support the sustainable trade of twelve species identified as priority species in *Action Plan for North America: Sustainable Trade in Turtles and Tortoises*. As part of this workshop, the participants visited the United States Fish and Wildlife Service (USFWS) Wildlife Inspection offices at the Port of Miami to learn methodologies and challenges associated with wildlife trade and enforcement. A closed-door enforcement session allowed confidential sharing of information among participants from the three countries who have enforcement responsibilities. Although the workshop focused on identifying how legal and sustainable trade can be facilitated and promoted under CITES, awareness of the magnitude of the illegal trade that is occurring was also discussed. Workshop participants outlined action items that may help promote sustainable legal trade, and also outlined suggestions and recommendations for addressing illegal trade. This workshop report includes information compiled by the facilitator prior or during the workshop to support discussions and is included in this report as reference.

Executive Summary

The Commission for Environmental Cooperation (CEC) held the Trinational Trade and Enforcement Training Workshop to Support the Legal and Sustainable Trade in Turtles and Tortoises, in Miami, Florida, United States, from 24 to 26 October 2018. The development of this workshop was identified as a priority action in the *Action Plan for North America: Sustainable Trade in Turtles and Tortoises* (CEC 2017). The workshop's overarching objectives included: 1) sharing of information about freshwater turtle and tortoise science and trade, and 2) identifying how legal and sustainable trade could be facilitated in North America to maintain the viability of wild populations of the twelve priority species selected. The workshop participants were a diverse group of people, and included government officials; biologists from nongovernmental organizations (NGOs); Convention on International Trade in Endangered Species (CITES) authorities; scientists; conservation and species recovery ecologists; and enforcement agents and intelligence analysts from Canada, Mexico and the United States. The suggestions and recommendations presented in this report do not necessarily reflect consensus among the workshop participants, nor should they be considered wholly endorsed by the state, provincial, or national governments of Canada, Mexico, or the United States.

The workshop was organized in different sessions, with the first session focusing on conveying and sharing general information and understanding about the Convention on International Trade in Endangered Species (CITES) and its Appendices and on the main threats that turtle and tortoise populations are facing. Information on turtle ecology and life-history traits, specifically focusing on age-specific survivorship, age at maturity, longevity, and reproductive output and frequency, was provided during the conservation session. Of all vertebrate groups, chelonians (turtles and tortoises), represented by approximately 356 species worldwide, show some of the most precipitous declines, with more than 56% listed as Threatened on the most recent Red List of the International Union for the Conservation of Nature (IUCN). However, it was noted that information is not available for all twelve CITES Appendix II priority species that were the focus of this workshop. The workshop highlighted the need to acquire more biological knowledge of these species for consideration by regulatory agencies of all three countries, especially when trying to make non-detriment findings (NDFs) regarding trade impacts and assessments of sustainable trade of species. This report includes information compiled by the facilitator prior to the workshop to help determine the current obligations and programs for data collection and reporting relevant to turtles/tortoises in the *Action Plan for North America: Sustainable Trade in Turtles and Tortoises* (CEC 2017). This background information provided before or during the workshop gave context to workshop discussions. In addition, this report includes a compilation of information on each of the twelve priority species, which could serve as a valuable resource to managers, law enforcement officers, and CITES authorities.

The Management Session covered a diverse array of topics, including data on trade volumes and numbers available in the trade databases of both CITES and the Law Enforcement Management Information System (LEMIS) of the United States Forest and Wildlife Service (USFWS). Discussions included concerns over the types of data available in those databases, and explanation of the coding systems used on CITES permits. There was discussion as well about the potential marking of turtles and its utility in identifying traded specimens. The participants discussed and debated factors that define the meaning of sustainable trade and sustainable harvest. Issues identified included the lack of knowledge about illegal trade in these priority species, and the current knowledge available about illegal turtle trade in general, particularly in Asia. Recommendations included the compilation and update of biological data available for the twelve priority species.

CITES strives to facilitate legal trade, and NDFs and export quotas are derived from the known data regarding legal trade. However, as became evident during the visit to the USFWS Miami Port Wildlife Inspection offices, the magnitude of wildlife trade is great. Enforcement agents work tirelessly to inspect wildlife shipments for legal trade and to detect illegal activities. Enforcement agencies and staff need continued support and increased funding; and sharing of information could be promoted, including collaborations with conservation scientists, whenever it is appropriate to do so.

During the workshop, participants highlighted the importance of public awareness. For example, there is high public awareness of the status of *Dermatemys mawii* in Mexico. A project was developed among local communities to both produce turtles for consumption and recover wild populations. This project has a high probability of success if it compiles the correct information and the knowledge is disseminated. A recommendation that arose from discussions on public awareness was the development of an outreach campaign with a common message to engage the public, such as the one developed by the CEC for the monarch butterfly. A similar approach for selected species of turtles may prove beneficial.

During the session on captive breeding, discussions focused on defining well-regulated and certified operations for commercial wildlife trade and addressed the valuable contribution of partners to conservation and species recovery. Discussions considered that captive breeding could be factored into the solution rather than be a potential problem. Regulations and oversight of captive-breeding facilities vary among and within the three countries. Captive breeding may, in some cases, function as illegitimate laundering operations for wild, illegally-procured turtles. Captive breeding, for commercial purposes, must therefore be able to account for the numbers of breeding stock from which hatchlings and juvenile turtles are produced for the trade. For example, documentation of individual breeding stock, through shell marking, passive integrated transponder (PIT) tags, photographs, and permits could address this problem. A process to certify legitimate breeders was discussed, and whether or not it should be the role of state/provincial agencies in United States and Canada or agencies certifying

the Wildlife Management and Sustainable Use Unit (UMA) in Mexico to decide if current operations would be "grandfathered." Two points considered during the discussions were the management of confiscations of illegally traded turtles, and the potential role of confiscations in species recovery projects. Further discussions are needed to address the issue of confiscation.

Workshop recommendations included the development of an experimental pilot study using limited and regulated harvests of turtle nests to mimic collection for commercial trade, specifically of diamondback terrapins (*Malaclemys terrapin*). Using a population known to be growing and not currently under threat, the partial harvest of nests under controlled conditions may mimic commercial trade. Monitoring of this population for continued stability should be done. A study with this design could help provide information on the sustainable harvest and trade of wild turtles.

Participants remarked that the information provided was extremely enlightening and that this workshop was important for building relationships between participants who came from different countries and agencies and had vastly different perspectives (e.g., university scientists, special agents, regulators). Relevant information was shared and different perspectives were discussed regarding solutions to promote the sustainable and legal trade for turtles and tortoises in North America. Overall, the workshop provided help to direct turtle conservation and management toward solutions for current issues.

Acknowledgements

The facilitators of the workshop express their gratitude to the people listed below for their support and input in developing this report:

Steering Committee:

Carolina Cáceres, ECCC; **Thomas Leuteritz**, USFWS; **Charles-Antoine Sirois**, ECCC; **Rosemarie Gnam**, USFWS; **Cora Deshield**, ECCC; **Francisco Navarrete Estrada**, Profepa; **Gina Schalk**, ECCC; **José Luis Pedro Funes**, DGVS-Semarnat; **Anne St. John**, USFWS; **Hesiquio Benítez**, Conabio; **Laura Noguchi**, USFWS; **Paola Mosig**, Conabio; **Neil Gardner**, USFWS

CEC Secretariat management team:

Georgina O'Farrill, **David Donaldson**, **Simonetta Ferrante**, **Monica Navarro**

Preface

The Commission for Environmental Cooperation (CEC) publication entitled *Action Plan for North America: Sustainable Trade in Turtles and Tortoises* was developed in 2017 and outlines priority actions identified by government experts and stakeholders from Canada, Mexico, and the United States to support the sustainable trade of turtles and tortoises in North America. The Turtle and Tortoise Action Plan is one of five completed action plans. The other plans cover tarantulas, parrots, sharks, and timber and are available at the CEC's website (‹www.cec.org›). The plans are designed to help promote sustainable trade in North American native species listed under Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES, ‹www.cites.org›), and were produced under the guidance of the CEC and with CITES authorities. The 2017 Action Plan for Turtles and Tortoises focused on twelve previously-selected species representing three families (*Dermatemydidae*, *Emydidae*, *Testudinidae*). The Trinational Trade and Enforcement Training Workshop to Support the Legal and Sustainable Trade in Turtles and Tortoises was held in Miami, Florida, United States, and its outcomes will help implement key recommendations of the action plan for these priority species, as well as identify additional priority actions through sharing of information, discussion, and collaboration on ideas. This workshop report includes background information compiled by the facilitator to support workshop discussions or as reference information. In addition, this report includes action items outlined by workshop participants that may help promote sustainable legal trade, and suggestions and recommendations for addressing illegal trade. The suggestions and recommendations presented in this report do not necessarily reflect consensus among the workshop participants, nor should they be considered wholly endorsed by the state, provincial, or national governments of Canada, Mexico, or the United States.

Glyptemys insculpata (wood turtle) Kurt A. Buhlmann

1. Introduction

The Commission for Environmental Cooperation (CEC) organized and held the Trinational Trade and Enforcement Training Workshop to Support the Legal and Sustainable Trade in Turtles and Tortoises (hereafter, "the workshop") in Miami, Florida, United States, from 24 to 26 October 2018. The CEC organized the workshop to follow the priority actions identified in the 2017 publication entitled Action Plan for North America: Sustainable Trade in Turtles and Tortoises. The Action Plan was developed during 2016–2017 and included priority actions identified by government experts and stakeholders from Canada, Mexico, and the United States to support the sustainable trade of turtles and tortoises in North America (CEC 2017). The Action Plan listed priority actions focused on 12 previously-selected CITES Appendix II species representing three families (*Dermatemydidae, Emydidae, Testudinidae*) and included seven genera. The group is collectively diverse in natural history and includes five aquatic/semi-aquatic turtles, three primarily terrestrial box turtles, and four land tortoises. The most recent Red List assessments by the International Union for the Conservation of Nature (IUCN) and draft updates by the Tortoise and Freshwater Turtle Specialist Group (TFTSG) indicate that two of these species are Critically Endangered (CR), four are Endangered (EN), three are Vulnerable (VU), two are Near-Threatened (NT), and one is Data Deficient (DD). The workshop focused on the state of knowledge, including conservation, management, and enforcement needs (See Annex A), for the 12 priority species (Table 1) included in the Action Plan.

Table 1. Priority turtle and tortoise species

Scientific Name	Range	Habitat	IUCN (current)	TFTSG (2018)
Dermatemys mawii	MX	Lowland rivers and floodplain lakes and lagoons	CR	CR
Glyptemys insculpta	CA, US	Streams/Fields/Woods	EN	EN
Clemmys guttata	CA US	Wetlands/Marshes/Swamps	EN	EN
Emydoidea blandingii	CA, US	Marshes	EN	EN
Malaclemys terrapin	US	Salt marshes / Brackish waters	NT	VU
Terrapene carolina	CA, MX, US	Fields/ Wood edges	VU	VU
Terrapene nelsoni	MX	Likely neotropical short-tree forest, thorn scrub, oak woodland	DD	DD
Terrapene ornata	MX, US	Prairies/Fields/ Scrub desert	NT	NT
Gopherus agassizii	US	Mojave Desert	VU	CR
Gopherus morafkai	MX, US	Sonoran Desert	VU	VU
Gopherus berlandieri	MX, US	Thornscrub	NE	NT
Gopherus polyphemus	US	Longleaf pine–wiregrass savanna	VU	EN

Note: IUCN = International Union for the Conservation of Nature; TFTSG = IUCN Tortoise and Freshwater Turtle Specialist Group; CR = Critically Endangered; DD = Data Deficient; EN = Endangered; NE = not evaluated; NT = Near-Threatened; VU = Vulnerable; CA = Canada; MX = Mexico; US = United States.

Source: CEC 2017, *Action Plan for North America: Sustainable Trade in Turtles and Tortoises*. The IUCN categories are listed in the IUCN Red List website (<www.iucnredlist.org>); those proposed by the IUCN TFTSG are from: Tortoise and Freshwater Turtle Specialist Group (TFTSG). 2018. Global conservation status of turtles and tortoises (Order *Testudines)*.

1.1 Workshop Objectives

Workshop objectives were the following:

1. Share information on ecology, biology, conservation and management experience, science to promote sustainable use, and law enforcement issues and strategies regarding the trade of the 12 priority species of turtles and tortoises, to support CITES implementation.
2. Discuss methods that could result in the reduction of unsustainable and/or illegally sourced specimens, and influence market demands and supply.
3. Support, by offering new alternatives, the development of policies and actions that promote the recovery, sustainable use and conservation of wild populations.
4. Promote legal, sustainable, and traceable trade.

Conservation

1. Discuss the ecological status of the 12 priority species included in the Action Plan, considering distributional occurrence, population status, life-history traits (especially reproductive biology, age at maturity, survivorship).
2. Identify threats (in addition to trade) to the species.
3. Identify research and knowledge gaps and potential strategies to address them.
4. Discuss implications for life history from the wild harvest of these species and discuss the sustainability of current harvest levels.
5. Identify key elements for formulating non-detriment findings (NDFs) for these species.
6. Discuss captive breeding, ranching, and farming of turtle and tortoise species, and the opportunities and/or adverse effects of these activities on the conservation and sustainable use of wild populations.
7. Make recommendations on conservation measures, especially those "outside the box," that could lead to sustainable trade as well as guarantee viability of populations in the wild.

Management

8. Share understandings of existing trade (import/export) information sources and databases from state/provincial agencies, national agencies (including, e.g., Endangered Species Act, Species at Risk Act, NOM-059), and international bodies (CITES).
9. Discuss current strategies and regulations that apply to Canada, Mexico and the United States, and their effectiveness for turtle and tortoise conservation.
10. Make recommendations to improve current management and regulatory regimes and on any measures needed to strengthen understanding of the level and effects of trade on the conservation/sustainability of freshwater and terrestrial turtles.
11. Identify management actions that will promote recovery, conservation and sustainable use of wild populations.
12. Consider raising consumer community awareness, and define the most feasible ways/strategies to accomplish doing so.

Law Enforcement

13. Highlight the problem of illegal turtle and tortoise collection and trade.
14. Identify training, information, and resources needed for appropriate investigative and enforcement actions to detect and respond to illegal turtle and tortoise trade and to protect wild populations. Thus, build enforcement capacity.
15. Assess and make recommendations to improve enforcement, compliance, and intelligence-sharing collaboration among countries, states/provinces, and state/provincial and federal enforcement authorities (state-state collaboration and federal-state collaboration).
16. Establish a list of variables for measuring project outcomes (e.g., indicators to evaluate enforcement action outcomes).

Glyptemys insculpata (wood turtle, juvenile) Kurt A. Buhlmann

2. Background Information

2.1 International Union for the Conservation of Nature (IUCN)

The IUCN has a mission to "influence, encourage and assist societies throughout the world to conserve the integrity and diversity of nature and to ensure the use of natural resources is equitable and ecologically sustainable" (IUCN 2018). The IUCN Red List of Threatened Species (<www.iucnredlist.org>) is the global standard for threat assessments and determination of conservation status of all species of animals and plants. The IUCN's Tortoise and Freshwater Turtle Specialist Group (TFTSG) recently proposed revisions for the order Testudines, which generally includes 356 species. IUCN specialist groups are composed of the world's experts in various taxa (TFTSG <www.iucn-tftsg.org>), and statuses of species are updated as needed. The current number of chelonian species in each IUCN Red List category is as follows, in Table2.

Table 2. Number of turtle species, by IUCN Redlist category

Number of species (356 Total)	IUCN Red List category
7	Extinct (EX)
1	Critically Endangered (CR, Possibly Extinct)
63	Critically Endangered (CR)
50	Endangered (EN)
65	Vulnerable (VU)
38	Near Threatened (NT)
81	Least Concern (LC)
35	Data Deficient (DD)
16	Not Evaluated (NE)

Source: Tortoise and Freshwater Turtle Specialist Group (TFTSG) 2018.

Worldwide, turtle diversity is highest in Asia, followed by North America (Buhlmann et al. 2009). Turtles and tortoises represent one of the most imperiled vertebrate groups, with 56.4% of the known species listed as critically endangered, endangered, or vulnerable (TTWG 2014). Globally, only primates have a higher percentage of threatened species (64.3%), while salamanders have a similar number (55.4%). Asia is at the epicenter of the global turtle extinction crisis that has rapidly developed as a result of unsustainable trade (Behler 1997; van Dijk et al. 2000; Gibbons et al. 2000).

2.2 Convention on International Trade in Endangered Species (CITES)

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is an international treaty signed in March 1973 and in effect since 1975 (Wijnstekers 2003). The goal of CITES is to ensure trade does not threaten species with extinction. Specifically stated, "International cooperation is essential for the protection of certain species of wild fauna and flora against over-exploitation through international trade" (CITES 1973). Member countries signing onto CITES are called "parties." As of January 2018, there were 183 parties, representing 182 countries and the European Union as a whole.

Overall, CITES ensures that international trade in wild fauna and flora is legal and sustainable. The Convention establishes a legal framework, together with common procedural mechanisms for regulating international trade in species; these mechanisms are implemented through adoption into national laws. The strictest regulation is placed on species threatened with extinction, and CITES safeguards legal and sustainable international trade in other listed species. For species listed in its Appendices, CITES regulates the export, re-export, and import of live and dead animals and plants, their parts, and derivatives. International trade is regulated based on a system of permits and certificates issued only if certain conditions are met and which must be presented when leaving and entering a country.

2.2.1 Definitions of CITES Appendices I, II, and III Species

Appendix I: Currently includes about 1,000 species considered threatened with extinction. In principle, international trade for commercial purposes is prohibited. Any movement between countries requires both an export permit and an import permit (<www.cites.org/eng/disc/how.php>).

Appendix II: Currently includes about 30,000 species vulnerable to overexploitation, but not at immediate risk of extinction. Commercial and non-commercial trade is allowed under specific protocols. CITES permits are required for export, but not for import. Exports must be determined to be both legal and non-detrimental. Preparation of a non-detriment finding (NDF) is the responsibility of the designated CITES Scientific Authority in the exporting country, while the determination of legal origin, as well as the issuance of permits, is the responsibility of the CITES Management Authority of the exporting country.

Regarding the 12 priority species that are the focus of this workshop, the tortoises (genus *Gopherus*) have been listed in Appendix II since 1 July 1975; the three box turtles (genus *Terrapene*) since 16 February 1995; wood turtles (*Glyptemys insculpta*) since 11 June 1992; spotted turtles (*Clemmys guttata*) and Blanding's turtles (*Emydoidea blandingii*) since 12 June 2013; and Central American river turtles (*Dermatemys mawi*) since 6 June 1981. The listing date also indicates the beginning of import and export data recorded in CITES databases.

Appendix III: Currently includes about 300 species. These species are protected in at least one member country, and assistance has been requested to help regulate trade. Commercial international trade is allowed from the country of listing, if legal; trade in specimens of the species from other countries of export requires a certificate of origin (i.e., not a CITES export permit, and no NDFs).

2.2.2 *Legal Acquisition Findings (LAFs) and Non-Detriment Findings (NDFs)*

A **legal acquisition finding (LAF)** indicates that a specimen to be exported was legally acquired—whether collected from the wild under applicable permits and regulations, through production at appropriately registered and supervised captive-breeding facilities, or legally imported. A legal acquisition finding is determined by a Party's Management Authority and needs to be made for specimens listed in Appendix I, II, or III.

When determining an LAF, the following factors may be taken into consideration, as applicable:

- CITES Appendix listing of the specimen.
- National or local legislation prohibiting or regulating harvest from the wild.
- Seasonal closures.
- Protected areas and other areas closed to the collection.
- Permitted and prohibited methods of capture.
- Size and weight limits—minimum/maximum limits for collection.
- Harvest quota, export quota, or both.
- Captive-breeding and aquaculture laws and regulations.
- Legal origin of breeding stock in captive-breeding facilities, following Res. Conf. 10.16 (Rev).
- Correct application of source codes W, R, C, D, or F, (see Section 4.2.3) following Res.Conf. 12. 3 (Rev. CoP17).
- Registration details of the captive-breeding facility.
- Documented ability of the species to breed successfully in captivity or be reared in ranching operations.
- Research permits for shipments of scientific specimens or samples.

A **non-detriment finding (NDF)** is a conclusion by a Scientific Authority that the proposed export of specimens of a species will not negatively affect the survival of that species in the wild. NDFs are an integral part of the management of international trade in wild-collected specimens of species listed in CITES Appendix I or II, and specimens from some captive production systems and other sources. To reach a determination of NDF, the Authority must review the status, biology, and trade of the species considered for export; verification of the export specimens as belonging to the species is therefore essential. Applicable laws, regulations, exemptions and previously determined NDFs regarding production systems, among many other issues, should be reviewed.

In particular for turtles, to evaluate the potential intrinsic risks of wild turtle harvest, NDFs should indicate what proportion of the population is subject to exploitation, and the capacity of the species to recover from harvest. An NDF process is a method to determine sustainability—a risk assessment of whether a proposed export will be detrimental to a species' survival, its ecological role, or both. Guidance for the preparation of NDFs for tortoises and freshwater turtles can be found in CITES document AC28 Doc 15 (see Resources section).

2.2.3 CITES Implementation in North America

2.2.3.1 Canada

In Canada, provinces have jurisdiction over wildlife within their borders (on provincial and private lands), whereas the federal government has control over international trade and trade in specimens originating from federal lands. Therefore, management of freshwater turtle populations is the responsibility of both provincial and federal governments, whereas CITES authority and implementation rests solely with the federal government. Specifically, CITES requirements are embedded in Canadian legislation and implemented through the Wild Animal and Plant Protection and Regulation of International and Inter-provincial Trade Act (WAPPRIITA; see Resources section). Furthermore, the four priority turtle species native to Canada are all protected by federal and provincial conservation legislation. The federal Species at Risk Act (SARA) is the legislation that protects individual turtle species and their habitats on federal lands. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) is an arm's-length committee of experts who meet biannually to determine the status of at-risk Canadian species (see Resources section). The federal government considers COSEWIC's recommendations, for listing under SARA. Although the workshop focused on the export of turtles, it should be noted that Canada's Health of Animals Act, administered and implemented by the Canadian Food Inspection Agency (CFIA), prohibits the commercial importation of turtles; however, turtles may be imported for zoos, scientific study, and educational purposes.

As a result of this set of laws and regulations, turtle trade and exports from Canada are small in scale and scope. There are few imports into Canada from the United States recorded in the LEMIS database; however, illegal imports into Canada have been detected. Some turtle trade in Canada involves turtle parts for traditional medicine, though most is associated with the hobbyist-collector market for live turtles. Low levels of captive breeding by Canadian private hobbyists occur, but no large-scale farming facilities are known or licensed. Captive-bred turtles are mainly sold through online arrangements.

2.2.3.2 United States

In the United States, the management of native and invasive wildlife rests with the individual states. Priorities for species conservation often vary among species, given their distributions and conservation status within states. Therefore, collection, possession, and trade in turtles and tortoises may differ among the states. Species protected in one state but not another may still be legally exported if the exporter can document that the specimens were legally obtained. More recently, funding from the federal State Wildlife Grant Program (SWG) has allowed states to cooperate more effectively and work across state boundaries for the conservation of turtles and tortoises. The federal government also has jurisdiction over wildlife on federal lands, and those species listed as Threatened or Endangered under the Endangered Species Act (1973). The US Fish and Wildlife Service (USFWS) is the federal agency responsible for implementation of CITES.

2.2.3.3 Mexico

The Secretariat of Environment and Natural Resources (*Secretaría de Medio Ambiente y Recursos Naturales*—Semarnat) is responsible for protecting, restoring, and conserving ecosystems and biodiversity in Mexico, and is also responsible for promoting sustainable development and, ultimately, for implementing CITES. There are sub-departments within Semarnat that are responsible for specific programs: The General Directorate for Wildlife (*Dirección General de Vida Silvestre*—DGVS-Semarnat) is responsible for the management of wildlife in the country and is the CITES Management Authority. The National Commission for the Knowledge and Use of Biodiversity (*Comisión Nacional para el Conocimiento y Uso de la Biodiversidad*—Conabio) is responsible for improving knowledge about biodiversity and informing decisions on promoting its conservation and sustainable use, and is the CITES Scientific Authority. The National Commission for Protected Natural Areas (*Comisión Nacional de Áreas Naturales Protegidas*—Conanp) is responsible for managing protected areas and implementing action programs for the recovery and conservation of species at risk. And the Federal Attorney for Environmental Protection (*Procuraduría Federal de Protección al Ambiente*—Profepa) is the environmental enforcement institution within Mexico and is the CITES Enforcement Authority.

As CITES Management Authority, DGVS-Semarnat is responsible for issuing CITES permits and liaising with the CITES Secretariat. Export permits are supported by non-detriment findings (NDFs) prepared by Conabio, while Profepa enforces the Convention regulations. DGVS-Semarnat also manages the National System of Management Units for the Conservation of Wildlife (*Sistema de Unidades de Manejo para la Conservación de la Vida Silvestre; Mexico*—SUMA), which includes the approval of plans for Wildlife Management and Sustainable Use Units (*Unidades de Manejo y Aprovechamiento Sustentable*—UMAs). The purposes of UMAs are the restoration, protection, maintenance, recovery, reproduction, repopulation, re-introduction, rehabilitation, exhibition, recreation, and sustainable use of wildlife, and the environmental education of the public (DOF 2000).

The General Wildlife Law (*Ley General de Vida Silvestre*—LGVS) regulates the sustainable use, conservation, and management of native wild animals and plants. It regulates the protection of species or populations that are at risk, including both terrestrial and aquatic species (DOF 2000; Linder and Kaplan 1952; DOF 2016). The LGVS establishes the national policy for wildlife protection and sustainable use via the SUMA program and the Mexican Official Standard (*Norma Official Mexicana*) NOM059-SEMARNAT-2010 (NOM-059) on Mexican species at risk. Additionally, the LGVS regulates the creation of UMAs. Article 55 of the LGVS implements CITES in Mexico. The LGVS also includes some provisions that are stricter than those required by CITES.

The Official Mexican Standard (*Norma Oficial Mexicana*) NOM-059-SEMARNAT-2010 defines the criteria that must be met for a species to be considered "at risk," provides the criteria for reviewing the conservation status of native Mexican terrestrial and aquatic species of animals and plants and categorizes those species that require special protection (DOF 2010). The use of NOM-059 species is allowed only under a UMA framework, and hence a management plan approved by the DGVS-Semarnat. NOM-059 establishes four risk categories: Probably Extinct (in the wild), Endangered, Threatened, and Subject to Special Protection (DOF 2010).

3. Conservation Biology Session

3.1 Overview

During this session, participants (see Annex B) were presented with information on the life history of turtles and with more-specific information on the 12 priority species (see Annex C). There were seven main topical objectives, which ranged from general ecological status to more-fine-tuned, necessary actions for the priority species (Table 3). Presentations during this session provided baseline knowledge of the conservation needs for many of the priority species, and subsequent discussions focused on: how existing biological information on the species could be used to assist with NDFs; determinations of captive breeding potential; data gaps in the life-history and ecological knowledge of the priority species; and identifying actions that are necessary to determine and promote sustainable trade.

Table 3. Conservation biology session objectives

1. Discuss the ecological status of the 12 priority species included in the Action Plan, considering distributional occurrence, population status, life-history traits (especially reproductive biology, age at maturity, survivorship).
2. Identify threats (in addition to trade) to the species.
3. Identify research and knowledge gaps and potential strategies to address them.
4. Discuss the implications of life history for the wild harvest of these species and discuss the sustainability of current harvest levels.
5. Identify key elements for formulating non-detriment findings (NDFs) for these species.
6. Discuss captive breeding, ranching, and farming of turtle and tortoise species, and the opportunities/ adverse effects of these activities on the conservation and sustainable use of wild populations.
7. Make recommendations on conservation measures, especially those "outside the box," that could lead to sustainable trade and guarantee the viability of populations in the wild.

3.2 Life History of Turtles

Overall, turtles and tortoises have a suite of life-history characteristics complicating their population management, conservation, and recovery. Chelonians are often quick to respond to perturbations and slow to respond to recovery efforts. The suite of life-history characteristics also present challenges for sustainable trade and harvesting. The major life-history traits requiring consideration are as follows:

- High hatching mortality, whereby entire annual reproductive bouts may succumb to nest predation.
- Low survival rates in younger age classes, particularly in the first few years.
- Delayed sexual maturity in adults—individuals do not become reproductively mature until later ages, when survival rates are much greater.
- High adult survival rates, with the result that many turtles have long reproductive lifespans and extreme longevity, which then offsets lower fecundity and lower juvenile survivorship.

While turtle life-history characteristics promote a buffer to some stochasticity (varying in parameters affecting lifespans and population growth), when acting in synergy, the traits can compound population declines. The traits result in quick declines when turtle populations face chronic perturbations (Congdon et al. 1993, 1994) and populations are concurrently slow to respond to recovery, even after the elimination of threats. For example, Spencer et al. (2017) modeled life history of Eastern long-necked turtles (*Chelodina longicollis*) in Australia, and found that despite high levels of nest predation, the turtle population still maintained a population growth. However, at nest predation rates of 95%, the risk of extinction increases; but if once every 10 years nest predation is less than 60%, enough recruitment occurs to maintain the population. However, when less than 1% of the adult population (2% of adult females) is harvested from the population each year, the risk of extinction remains high (>60%). Thus, over-exploitation of adults (particularly females) results in declines in population, which then take decades to recover, if they ever do (Spencer et al. 2017).

Turtles can appear on the landscape for decades, and thus give the appearance of persistence, while the populations may be demographically extinct (Lovich et al. 2018). Thus, turtle life-history traits not only complicate conservation, management, and recovery, they present a challenge for determining if sustainable harvest levels can be achieved.

3.3 Life History Summary of Priority Species

The life-history trait values for the 12 priority turtles were compiled from numerous published scientific journals (Table 4). The most important life-history data necessary for population modeling include annual survivorship (for hatchlings, juvenile age classes, and adults), clutch size and clutch frequency, age at maturity, and longevity. Because most turtles are long-lived—as long as humans in many cases—obtaining the data has proven difficult for conservation biologists. Thus, complete life tables or matrix-based demographic analyses have been compiled for only a few turtle species.

General trends among the twelve species indicate that most are relatively long-lived (40+ years) and have delayed sexual maturity (> 6 years, and up to 20 years; Table 4), although some modeling results suggest shorter lifespans in some species (e.g., Berlandier's tortoise, <20 yrs; Hellgren et al. 2000; Kazmaier et al. 2001). Although some species can lay relatively large clutches, the commonality among all is that most have low reproductive output per breeding cycle, and reproduction often shows as the lowest contributor to population growth rates in turtles (Heppell 1998). Even when factoring in the potential for multiple clutchings, clutch size, and thus annual reproduction in the priority species, appears low. Such low relative values of reproductive output and of delayed sexual maturity may hamper productivity in captive-rearing/farming operations. Most species tend to suffer high nest mortality and hatchling mortality, but a long reproductive lifespan often counters such trends. However, studies among the priority species found that populations may suffer 100% nest mortality in some years (i.e., wood turtles—*Glyptemys insculpta*; Buhlmann and Osborn 2011). Survivorship increases as a function of size and age in most turtle species (Shine and Iverson 1995), which is the case for the priority species (Table 4). In examinations of turtle demographics, adult survival typically makes the highest contribution to population growth rates, followed by juvenile and subadult survival rates (Heppell 1998). Given the global declines in turtle population due to a myriad of threats and the turtles' reduced ability to naturally recover from severe population perturbations, continued harvest of adult turtles from the wild without proper regulations is likely unsustainable and will compound population declines.

Table 4. Representative data for life-history traits, summarized for the priority turtle species

Life History Trait	*D. mawi*	*G. insculpta*	*C. gutatta*	*E. blandingii*	*M. terrapin*	*T. carolina*	*T. nelsoni*	*T. ornata*	*G. agassizii*	*G. morafkai*	*G. berlandieri*	*G. polyphemus*
Longevity (y)		40–58	28–38	50–78	14–40	50–80	-----	26–42	67–80	35–64	18-52	50–70
Sexual Maturity (y)	8 ♀	11–19	7–15	14–20	6–13	7–8	-----	8–11	15–20	10–20	5-13	9–21
Clutch Size: min-max		3– 20	1–5	3–22	4–23	1–11		1–8	1–8	1–12	1–4	1–25
Clutch Size: (ave. range)	(10-24)	(8–11)	(2-4)	(8 - 14)	(6–15)	1–3	1–4	(4–5)	(3–5)		(2-3)	(3–9)
Clutch Frequency	2	1	1	1	2–3		-----	1–2	1–2	1	1–2	1
Proportion Breeding		68%	1–2	48%			-----	10–61%		78%	31–37%	70.3%
Nest Survival	-----	65–75%	52– 68%	0–63%	1–84%	55–95%	-----	42-80%	------	-----	52%	11–45%
1st-year Survival			54.6%	26%		-----	-----	31%	51%	------	------	-----
Juvenile Survival	~80%*	82–83%	21–47%	72–78%		43– 100%	-----	72%	71–89%	------	54%	45-75%
Adult Survival	Unk.	87–97%	84-96%	93–100%		68–100%	-----	81–96%	75–98%	94–97%	79%	89%
Citations	Vogt et al. 2011	Oliver 1955; Harding and Bloomer 1979; Walde et al 2007; Saumure et al 2007; Greaves and Litzgus 2009; Schneider et al 2018	Ernst 1970a; Litzgus and Brooks 1998a; Litzgus and Mousseau 2006; Feng 2018	Congdon et al 1983; Congdon et al 2000	Lovich and Gibbons 1990; Roosenburg 1992; Roosenburg and Dunham 1997	Schwartz and Schwartz 1991; Ernst and Lovich 2009; Keister and Wiley 2015	Buskirk and Ponce-Campos 2011	Legler 1960; Ernst and Lovich 2009	Germano 1994a,b; McLuckie and Friedell 2002	Averill-Murray et al 2002; Germano et al 2002	Judd and Rose 1989; Hellgren et al 2000; Kazmaier et al 2001	Diemer 1986; Tuberville et al 2009;

3.4 Critical Data Gaps for Priority Species

For many species, there are one or two seminal ecological and life-history studies, such as Congdon et al. (1993) for the Blanding's turtle, and Schwartz and Schwartz (1991) for the Eastern box turtle. For most species, workshop participants agreed that some data exist to determine the effects of harvest; however, the current data are often restricted to one site, or specific life-history components are missing and must be derived from closely related species (see Annex C). This observation was supported through an extensive literature review to inform Annex C. This compendium of information identifies that no species has an adequate range-wide compilation of all major life-history characteristics, and thus, assessing any potential impacts to population growth rates is hampered. Many of the priority species, such as the Eastern box turtle and the diamondback terrapin, have broad geographic ranges; therefore additional errors in assessments may be compounded by not accounting for clinal variation (variation in adjacent populations) in trait values. Lacking geographic representation of traits that influence the demographics of a species may further reduce the accuracy of any conservation-related or harvest targets.

Through the review of the available information in the literature, it was found that many species are lacking quantification of one or two critical variables (Annex C). Annex C includes all available information compiled on the twelve priority species; however, it is possible that some data may exist, either in gray literature sources (technical reports to regulatory agencies, or graduate theses and dissertations) or in a raw and unanalyzed format. For example, for the Central American river turtle, workshop participants from Mexico were able to include, in the compilation of information, data not readily available. Workshop participants agreed that there are knowledge gaps in the ecology and life history of two species: the Central American river turtle and the spotted box turtle. For example, the life expectancy of the Central American river turtle is unknown and there is no current knowledge on the geographical distribution and habitat type of spotted box turtles, where they are found.

3.5 Actions to Fill Data Gaps

Workshop participants discussed and agreed that although the best data for turtle life histories derive from long-term studies of populations, preliminary data derived from shorter periods can assist with determining conservation measures and potential impacts to populations. Additionally, with so many populations in decline globally, turtle conservation no longer has the time necessary to collect full data. Therefore, a more rapid and focused approach becomes necessary to fill in the life-history data gaps; for example, as follows:

A. Stage-structured data: Because the major determinants of population growth are tracked demographically using females, all subsequent potential conservation actions should mainly focus on females. Collecting the necessary data can stem from a three-tiered study using intensive mark/recapture, radio-telemetry, and x-radiography. The use of those three methods can provide stage-structured results for initial assessments, with potential size- or age-structured results.

B. Population information: Intense mark/recapture will provide insights into population sizes, population structure, and sex ratios, in addition to growth analyses. Growth analyses can then be used to estimate longevity and age of maturity. Such studies will require an ontogenetic series of individuals and ages of maturity that can be corroborated with reproductive data. Intensive mark/recapture will only work in regions or on populations that remain robust, because gathering the necessary life-history data in a short time will require larger numbers of turtles. Thus, there must be some previous knowledge of the species' status within the region for a suitable study site to be chosen.

C. Reproduction information: All females captured during intensive mark/recapture should be palpated and x-rayed. X-radiography will provide estimates of clutch size, and clutch frequency. Additional data could include female reproductive cycles if females are captured serially across years. Although reproductive factors do not show strong ties to population growth rates in turtles, assessing these vital rates are imperative for constructing demographic assessments.

D. Survival information: Radio-telemetry effort can be infrequent and minimized to only determine if individuals are alive or dead. Transmitters on gravid females would determine nest locations, success, and survival. Those same nests can then provide individual hatchlings to track and determine their survival rates. The goal of telemetry studies should be to determine survival and nest success, but more frequent tracking could assist with movement, home range, and habitat use designations.

All these studies are not mutually exclusive and can occur concomitantly. If a large enough ontogenetic series of turtles is captured, the entire process could start producing results for at least a stage-based analysis within three years. Keeping the process shorter is more viable, considering logistics and funding. The studies can be expensive, regarding equipment, supplies, and field crews; however, after the initial project is established, continuing operation becomes cheaper, especially if radio-telemetry is solely focused on annual survival rates.

4. Management and Trade Session

4.1 Overview

During this session, participants were given additional information on laws, regulations, and processes which would affect trade in Canada, Mexico, and the United States. For this part of the workshop, five objectives were addressed, either in presentations or through group discussions (Table 5). Discussions focused on information and data sources, coordination of trade management across North America, captive breeding, confiscations, marking of turtles in trade, and public awareness.

Table 5. Management and trade session objectives

1. Share understandings of existing trade (import/export) information sources and databases from state/provincial and national agencies (including, e.g., Endangered Species Act, Species at Risk Act, NOM-059), and international agencies (e.g., CITES).
2. Discuss current strategies and regulations that apply to Canada, Mexico, and the United States, and their effectiveness for turtle and tortoise conservation.
3. Make recommendations to improve current management and regulatory regimes and any measures needed to strengthen understanding of the level and effects of trade on the conservation and sustainability of freshwater and terrestrial turtles.
4. Identify management actions that will promote recovery, conservation and sustainable use of wild populations.
5. Consider raising consumer community awareness and define the most feasible means to accomplish doing so.

4.2 Information and Data Sources

4.2.1 CITES-UNEP/WCMC Database

A trade summary for the 12 priority species was obtained by querying the CITES Trade Database (<www.cites.org>). Records were only available through 2017. Other export records from the USFWS LEMIS database were sought through a *Freedom of Information Act* request for the workshop.

An initial summary of CITES trade records for the 12 priority species is presented in Table 6. Records for 2000–2016 (Table 6 header rows 00–16,) were downloaded in September 2018. No records are available for 2018, and those for 2017 may not be complete. For the workshop, we summarized all "live" and "specimen" exports for the 12 priority species from Canada (CA), United States (US) and Mexico (MX). Numbers provided are only for exports identified as "live."

For purposes of our understanding, CITES exports/imports designated as "specimen" are presumed to represent scientific samples (such as genetic blood or tissue samples—CITES Article 1, paragraph b; Wijnstekers 2003) or processed wildlife parts (carvings, shell, jewelry, etc.). The workshop did not focus the discussion on exports/imports listed as "specimens" under CITES.

No entries for the Sonoran desert tortoise (*Gopherus morafkai*) were available, possibly because specimens have been internationally traded as synonymous with the Mojave Desert tortoise (*Gopherus agassizii*). For box turtles, genus *Terrapene*, records are often listed as *Terrapene* sp. or spp. Numerous export records for species such as *Clemmys guttata, Glyptemys insculpta*, and *Malaclemys terrapin* occur from countries other than Canada, Mexico, and the United States, likely indicating captive-breeding endeavors in those countries. For example, a turtle farm with captive North American species was recently investigated in Spain (<https://apnews.com/bbc892bacd1947869893e9b59df920e7>).

Luiselli et al. (2016) analyzed the CITES database for 1990–2010 and found the greatest number of wild turtles being traded was at a peak in the early 2000s, with much of that trade representing exports from Asia. It is unknown whether the decrease that occurred after 2003–2005 resulted from CITES regulation and supervision, or a collapse of wild populations. However, there was a subsequent increase of turtles exported from North America, which was at least partly based on the listing by the United States of several widely-traded turtle species in Appendix III (thus adding to trade volume statistics).

4.2.2 USFWS Law Enforcement Information and Management System (LEMIS)

The USFWS maintains records of wildlife and plants, including turtle shipments in and out of the United States, in LEMIS. These records are not open source, and a *Freedom of Information Act* request must be submitted to obtain records that are releasable (i.e., not law enforcement–sensitive, or containing personally identifiable information). LEMIS data obtained for the workshop is summarized for each of the 12 species in Annex C. Usually, records obtained include: species, source (wild-caught, captive-raised, ranched, farmed, unknown), description ("live," or body parts–including "specimen" [e.g., genetic samples], carvings, shell, etc.), unit (numbers [if live], weight [gms, kgs, or lbs]), purposes (commercial, scientific, captive propagation), and ports of export (but not specifically where the turtles originated). Data such as the name of exporter or importer are not available through LEMIS data requests. Also, the life-history status of the turtles (i.e., whether hatchlings, juveniles, sub-adults, adults) is not available. LEMIS data differ from CITES data in that all species are recorded, not just those listed in CITES Appendices. Establishing LEMIS categories to identify turtles as hatchlings (< one year of age) or adults has been recommended (Mali et al. 2014).

4.2.3 CITES Export and Import Source Codes

USFWS CITES authorities outlined and described the codes attributed to turtles listed on CITES permits.

- I – Seized
- W – Wild collected – offspring of wild
- R – Ranched, taken as eggs or as wild juveniles, low probability of surviving to adulthood, reared in a controlled environment
- U – Source unknown, must be justified
- O – Preconvention specimen
- D – Appendix I bred in captivity for commercial purposes
- F – Animals born in captivity that do not fulfill the definition of captive-bred
- C – Bred in captivity under CITES Resolution 10.16 (Rev.)

Source Codes are defined in the online CITES Glossary: <https://cites.org/eng/resources/terms/glossary.php#s>. Guidance on determining which source code to use for a particular shipment is available in CITES information document AC30 Inf. 28: <https://cites.org/sites/default/files/eng/com/ac/30/Inf/E-AC30-Inf-25.pdf>.

Table 6. CITES trade data summary for gross exports of the priority turtle species, 2000–2016

Species	Nat	'00	'01	'02	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13	'14	'15	'16	Total
D. mawii	CA	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0
	US	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0
	MX	-----	50	20	-----	-----	-----	25	-----	-----	-----	-----	-----	-----	100	80	40	-----	315
G. insculpta	CA	-----	-----	-----	-----	-----	10	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	10
	US	-----	-----	-----	-----	10	-----	-----	-----	-----	-----	9	10	50	26	74	22	115	316
	MX	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0
C. guttata	CA	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	12	-----	-----	12
	US	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	77	128	144	349
	MX	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0
E. blandingii	CA	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0
	US	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	119	10	367	313	809
	MX	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0
M. terrapin	CA	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	10	-----	-----	10
	US	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	1592	14346	5324	6549	27811
	MX	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0
T. carolina	CA	-----	10	1	2	3	-----	-----	1	-----	-----	1	-----	1	1	23	-----	4	47
	US	24	26	7	10	12	14	1	24	2	26	28	6	1	3	16	3	2	205
	MX	1	-----	-----	-----	1	-----	-----	-----	-----	-----	-----	-----	-----	-----	1	-----	-----	3
T. nelsoni	CA	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0
	US	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0
	MX	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0
T. ornata	CA	1	7	-----	-----	-----	-----	-----	-----	-----	-----	-----	1	1	2	4	-----	-----	16
	US	41	13	-----	2	-----	-----	2	7	-----	-----	-----	-----	-----	9	1	1	1	77
	MX	2	-----	-----	2	2	-----	-----	-----	-----	-----	-----	-----	2	-----	1	1	-----	10
T. sp. or spp.	CA	-----	-----	-----	1	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	19	2	-----	22
	US	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0
	MX	-----	-----	-----	2	3	3	-----	-----	3	-----	2	-----	-----	-----	-----	-----	-----	13
G. agassizii	CA	-----	1	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	1
	US	-----	-----	-----	-----	-----	-----	1	-----	-----	-----	-----	1	-----	-----	-----	1	-----	3
	MX	4	4	4	8	7	2	4	-----	5	7	5	6	1	2	3	3	12	77
G. morafkai	CA	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0
	US	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0
	MX	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0
G. berlandieri	CA	-----	-----	1	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	1
	US	-----	1	-----	-----	-----	5	-----	-----	-----	-----	-----	3	-----	-----	-----	-----	-----	9
	MX	2	1	-----	-----	28	15	39	9	40	-----	15	76	81	30	84	73	89	582
G. polyphemus	CA	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0
	US	-----	-----	-----	-----	-----	2	-----	-----	-----	-----	-----	-----	1	-----	-----	-----	-----	3
	MX	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0
Gopherus spp.	MX	-----	-----	-----	-----	-----	-----	3	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	3
Total		75	113	33	27	66	41	75	41	47	33	58	103	138	1884	14761	5965	7229	30694

Source: Data from Luiselli et al. 2016.

During the Management and Trade session, Mexican colleagues indicated the need to establish better ways to identify turtles to a species level, as well as identify their source of origin. Participants discussed the benefit of including the prices of the animals exported/imported, as prices give some suggestion of size/age class (e.g., hatchling vs. adult), in addition to having numbers of turtles. From a life-history perspective, and for formulating NDFs, knowing the age class or size of turtle exported would represent valuable information useful for determining sustainable trade. Participants asked if these data, regarding size/age of turtles in trade, were available through LEMIS; the understanding is that this type of information is not recorded into the LEMIS database, even if it may be included in the permit application and the CITES permit itself. Guidance on determining whether turtle specimens in trade have originated from captive-production facilities or have been collected from the wild was being compiled by the CITES Secretariat at the time of writing of this report and would likely be available for the 2018 Council of the Parties (CoP18).

4.3 Coordinated Management

4.3.1 Coordination Between and Within Countries

A major goal of the workshop was to help identify ways to improve current management and regulatory regimes. CITES affects international trade and is a treaty agreed upon among "parties" in which agencies regulate domestic trade within a country. In the United States and Canada, wildlife is regulated primarily at the state/province level. Each state or province sets its harvest limits for wildlife and enables legislation that allows for possession and sale of wildlife. This is thoroughly described in the 2012 *North American Model of Wildlife Conservation* (Organ et al. 2012). States may also determine categories of rarity or endangerment and set their regulations accordingly. However, the USFWS can also list species as federally protected, and those regulations overarch the state regulations. Inconsistencies in possession regulations that vary by state/province within the range of a species of concern can lead to ambiguity, with regard to enforcement actions.

The domestic trade within countries (within and among states or provinces) needs to be addressed by the state/provincial wildlife agencies. Within the US, domestic trade of adult turtles can be regulated effectively if all states enact similar regulations. In the United States, the Lacey Act of 1900 is an important piece of legislation for combating illegal wildlife trade crossing state borders. A previous publication, *The State of the Union—Legal Authority over the Use of Native Amphibians and Reptiles in the United States* (Nanjappa and Conrad 2011), summarizes, by state, current regulations for all US native amphibians and reptiles. Mali et al. (2014) suggested that if turtle protection is a goal of conservation efforts, then states should work together to develop comprehensive regulation reforms.

4.3.2 Biological Survey and Regulatory Coordination in the US

Workshop participants discussed the importance of assessing wild population status. For example, there are studies from the State of Georgia (United States) on population surveys of the spotted turtle (*Clemmys guttata*), and the Partners for Amphibian and Reptile Conservation (PARC), through its Northeastern Working Group, recently completed an assessment of wood turtle (*Glyptemys insculpta*) status and conservation (Jones et al. 2018). Coordination among state and provincial wildlife agencies within the range of the spotted turtle would help to identify areas for coordinated conservation efforts, as well as weaknesses in regional enforcement or regulations. One of the presentations at the workshop made participants aware of PARC efforts to compile regulations for each US state, which would help

identify where regulations were complementary, conflicting, or inadequate. Efforts by PARC to update the current information are ongoing (*P. Nanjappa*, pers. comm.).

An example of state regulations on commercial trade of wild harvested turtles is provided by the South Carolina "Turtle" bill, which was enacted in 2009 and renewed without modification in 2014 (Section 50-15-70, SC Legislature). In brief, the South Carolina provisions state that: 1) a person cannot remove more than 10 turtles at a time from the wild; 2) sale is *not* prohibited; and 3) if more than 10 of these species are traded, the person must show that they came from a permitted aquaculture facility. Hence, there was an effort to preclude outright commercial harvest from the wild, while at the same time allowing for farming (i.e., aquaculture), and commercialization of farmed turtles. Note that the aquaculture applies to sliders and snapping turtles, which are raised in large numbers in farms in other states, such as Louisiana. For other species, presumably not farmed, and including Eastern box turtles, there were limits placed on the number of turtles that could be possesed at any one time.

Gopherus berlandieri (Berlandiers Tortoise), male left female right, Kurt A. Buhlmann

4.4 Traditional Wildlife Management

Workshop discussion allowed participants to present each country's wildlife management philosophy. Wildlife management in the United States and Canada has been summarized by Organ et al. (2012) and notes generally that wildlife resources are a public trust.

Harvest of long-lived species, such as turtles, should be considered differently from traditional game management. Traditional wildlife management often emphasizes harvesting the biggest, oldest, or both types of, animal. For stable populations of turtles and tortoises to persist in the wild, the adult animals (which require 15–20 years to reach that adulthood) are the most critical individuals for maintaining a stable or increasing population. Minimum viable populations (MVPs) of gopher tortoises (*Gopherus polyphemus*), for example, require more than 250 interacting adult individuals (Gopher Tortoise Council 2013).

In Mexico, the evolution of a wildlife management scenario proceeded differently. Land ownership in many cases is in the form of *ejidos* (community-owned lands) and therefore decision-making resides within communities rather than individuals, presenting both challenges and opportunities for a different type of management (Organ et al. 2012).

4.5 UMAs in Mexico

Mexico is developing sustainable and economically viable wildlife programs in the rural sector to alleviate poverty (Organ et al. 2012). The Wildlife Management and Sustainable Use Units (UMAs) were established in 1996. This is an innovative alternative for wildlife conservation and as of 2012, was in effect for 15% of Mexico's land; the UMA management system in Mexico presents both opportunities and challenges (Organ et al. 2012), specifically as follows:

1. UMAs benefit local landowners through sustainable use of their wildlife.
2. UMAs encounter issues with preservation vs. sustainable use. Also, they can operate *in situ* (preserving habitats), *ex-situ* (as captive-breeding operations), or can have both systems working (*in situ* with captive-breeding facilities).
3. Funding limitations: A UMA could be self-sustainable, but it also can operate on external funding. Sometimes, UMA activities are not profitable.
4. UMAs need management plans reviewed and approved by Semarnat, and have to submit periodic reports on their activities, success indicators, and restoration and conservation goals.
5. Any wildlife harvest is under the auspices of a UMA. That means that government knows how many individuals of any species are legally collected and traded (both national and international exports).
6. Most management of *in situ* UMAs is for conservation, and sustainable use (pets, hunting and ecotourism). *Ex situ* UMAs (captive-breeding facilities) are more likely to have trade as an objective, but also have to contribute to conservation and sustainable use of the species they manage.
7. To obtain the permission to enrich the captive population, a UMA must show the LAF (legal acquisition finding) of its captive-breeding stocks.
8. The focus of a UMA is on the human population living in that area, not the species.
9. Quotas for harvest are focused on species populations in the UMA, but not on a more regional approach.

10. For requesting a harvest quota, UMAs must provide Semarnat with information on annual population estimates. This can help determine trends in population dynamics; however, evaluation methodologies can vary among UMAs (and not be comparable between UMAs), and methodologies could be inadequate for certain species, or certain variables (e.g., estimating densities based on relative observations or evidence, etc.). Also, a UMA does not have to conduct a survey if it doesn't request a harvesting quota.
11. UMAs that manage turtles could benefit from a collaborative international program.

4.6 Captive Breeding

The participants at the workshop discussed captive breeding as a "tool" to help achieve the defined goal of sustainable turtle trade. Captive breeding was discussed as a potential means of counteracting the wild harvest of turtles for commercial trade. In theory, it is possible that removing turtles from the wild would decrease, as legitimate captive facilities provide captive-bred turtles to meet the trade demand. However, it was also clearly pointed out that the establishment of captive-breeding facilities would presumably involve the need for some level of wild-sourced breeding stock. Further discussions regarding this topic are still necessary.

On the subject of how captive-breeding facilities could be a viable partner in the sustainable trade of turtles, the following points were discussed by the workshop participants:

1. As captive-bred populations are established or current ones identified, and offspring produced therein are legally allowed into the trade, there should be reduced numbers of turtles removed from the wild to be traded.
2. Captive-breeding facilities may have different objectives: 1) commercial, 2) conservation, or 3) both.
3. Captive-breeding facilities need to be certified and hold valid permits. Designated agencies need to follow up with applicants that apply for permits every year.
4. Simply put, "Captive breeding needs sidebars" (this quote came from the workshop participants and indicated concerns regarding the permitting and certification of captive-breeding facilities).
5. Legitimate captive breeding should be addressed sooner, rather than later. Poaching from the wild for the illegal trade will increase as species increase in rarity.
6. The difference between farming and ranching needs further clarification.
7. Captive-breeding facilities might be approved by the states/provinces/UMAs in which they operate. Regulatory agencies need to determine best management practices (BMPs) for captive rearing, as well as for the domestic sale of turtles.

4.7 Marking and Identification Capacity

The necessity to mark individual turtles varies among species, the value, the level of conservation concern, and the volume of turtles in trade. The "values" vary greatly among species. Those species that are colorful and personable in captivity are often valued highly as pets. Those that are rare, or listed as endangered or threatened are, unfortunately, valued highly in the illegal trade. Individually identifying rare or high-value turtles would help monitoring of legal vs. illegal trade. Conversely, representatives from the State of Louisiana (United States) pointed out that large-scale farming of red-eared sliders (*Trachemys scripta*) produces thousands of low-value hatchlings of non-CITES-listed turtles and it would be unreasonable and unnecessary to mark them. For such species, legitimate turtle farming may need to

be encouraged through less regulation. Conversely, requiring registered and approved captive breeders to permanently mark and identify their breeding stock of wood, spotted and Blanding's turtles, as well as the offspring produced, seems a reasonable way to maintain the proper oversight of permitted captive breeding of species that are listed as threatened or endangered in their regions of occurrence.

Participants at the workshop suggested that government policies that promote captive breeding and sustainable trade in Mexico would be helpful for Berlandier's tortoise (*Gopherus berlandieri*), Central American river turtle (*Dermatemys mawi*), and spotted box turtles (*Terrapene nelsoni*).

4.8 Registry of Captive Breeding Operations

Captive breeding of tortoises and freshwater turtles occurs for two different purposes: 1) for commercial motives, to supply the pet, food and medicinal trade in turtles and turtle parts; and 2) for conservation-focused reasons, to increase the number of turtles available for augmentation of wild populations, or to keep "assurance colonies" of severely threatened, extinct-in-the-wild or nearly-so species surviving in captivity until re-introduction and population restoration can be attempted.

For responsible, transparent and traceable production of and trade from captive-breeding facilities, careful records of breeding stock inventory (males, females) and their origins need to be maintained, as well as detailed records of numbers of nestings, eggs, and hatchlings produced; and sales, mortality, and other forms of stock changes should be accounted for. Participants at the workshop noted that stock numbers tend to be somewhat uncertain at large ponds at long-established facilities (e.g., red-eared slider farms), where it is unlikely that all acquisitions were fully recorded and mortality often occurs without being noticed. But in the case of captive-breeding operations producing high-value specimens in intensively-managed smaller enclosures (e.g., wood turtles, Blanding's turtles, and most exotic species), facility managers should have a record of the species and numbers they have in their facilities.

Captive breeding for commercial trade might be facilitated by registering commercial breeders and their breeding stock. This could be accomplished on a case-by-case basis at the discretion of law enforcement, both at state and federal levels. Perhaps a nongovernmental organization, such as the Turtle Survival Alliance (TSA), could help facilitate a survey of captive-breeders, to better understand the current breeding stock of priority turtle species, as promoted in its mission statement: *Transforming passion for turtles into effective conservation action through a global network of living collections and recovery programs.* Such a certification process would involve visitation of captive facilities and certification of breeding stock (through marking), allowing for routine inspections, and incentives to produce animals for conservation, e.g., through head-starting. Head-starting for conservation means that hatchlings are raised in protected captive environments in order to achieve larger body sizes. Once they have achieved larger body sizes and have harder shells, their survivorship increases, because they are more predator-resistant. Once released into protected areas they can help enhance population recovery. Conversely, if the goal of captive breeding is to produce legal turtles for the pet trade, then "head-starting" techniques can help rear hatchlings turtles to a carapace length of the minimum four-inch size required to allow their legal entry into domestic trade (US CDC Code of Federal Regulations Title 21 CFR 1240.62).

Once registered—with breeding stock appropriately identified via marking systems (i.e., shell notching, PIT tags) and with coordinated activities (at least to country or state level)—those breeders might be able to engage effectively in international commercial trade as allowed under CITES rules. Permitted captive

breeding can and does provide turtles for domestic trade, and provides incentives for breeders to rear captive-bred turtles to the minimum-required 4-inch size (US CDC Code of Federal Regulations Title 21 CFR 1240.62) to supply the domestic demand for pet turtles. It is unclear whether a legal supply of older, larger turtles decreases the likelihood of turtles being collected illegally from wild populations.

Given that permitted captive breeding provides opportunities for commercial trade and profit, perhaps a well-designed permitting program would help identify some commercial breeders willing to contribute a portion of rare and threatened turtle species offspring in order to augment/recover wild populations, as well as allow a portion for commercial trade. Again, the consultants suggest that perhaps a nongovernmental organization, such as TSA or PARC could help facilitate those contacts.

For permitted captive-breeding programs, it was suggested during the workshop that perhaps only captive-bred male turtles be allowed to be exported, so that other countries would not be able to set up farms. Otherwise, the economic benefit of captive breeding in North America will become obsolete. There is major concern that there have been many years of export and that most of the species in question and both sexes are likely already in breeding programs outside of North America (e.g., in China).

In principle, appropriately regulated and approved captive-breeding programs could help reduce sourcing of wild turtles for trade. Nevertheless, it is widely argued that the process of a non-detriment finding and legal acquisition finding would still be required in order to evaluate that the collection of the parental stock was not detrimental to the survival of the wild population.

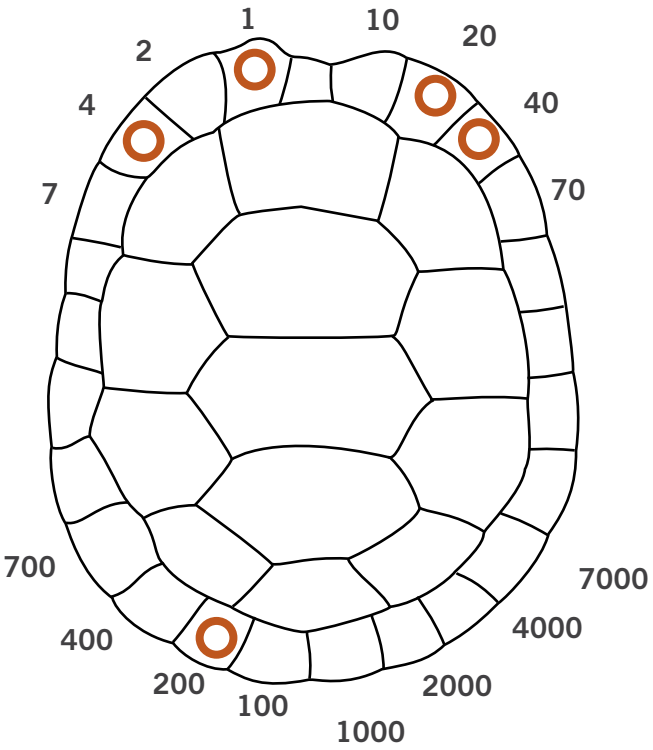
4.9 Traceable Trade

The use of shell-marking schemes has a long history in turtle field research (Cagle 1939; Buhlmann et al. 2008). Turtles are perhaps one of the easiest organisms to identify individually, as their carapace shells with their set numbers of marginal scutes allow for a numeric code system to be employed. For most species, the codes can be permanent, and involve file notching or drilling small holes. Hatchlings do present problems for long-term retention of marks, because of carapace growth, but there are alternative mechanisms, such as the passive integrated transponder (PIT) tags. PIT tags have been used with increasing frequency in amphibian and reptile research and monitoring projects (Graeter et al. 2013). However, coordination among researchers, state agencies, and captive breeders is a primary concern that needs to be addressed before a PIT tag system could be implemented to counteract illegal trade (Buhlmann and Tuberville 1998). PIT tags may be injected into turtle body cavities or injected under loose skin on the limbs. Workshop participants noted that for coordination among state and provincial wildlife agencies and approved/permitted captive-breeding facilities, codes can be assigned that would be unique to the state or breeding facility in question.

CITES resolutions (<https://cites.org/eng/res/index.php>) call for the marking of wildlife only in specific cases, mostly in situations where Appendix I specimens are produced in captivity (e.g., microchipped arowana, tail-clipped crocodiles, tagged crocodile skins). There is no requirement for Appendix II specimens to be identified. But although there is no requirement, workshop participants discussed that marking, leading to individual identification, could be very helpful for managing harvest of wild turtles, as well as for accountability and management of captive-breeding operations. Several US state wildlife agencies are requiring turtles in wild populations to be marked, either via shell notching or PIT tags (both discussed below). The State of Ohio requires PIT tagging of pet turtles (C. Caldwell, W. Roosenburg, pers. comm.) as well as wild turtles in mark-recapture field studies. The State of New Jersey

maintains the master database for wood turtles marked in field studies and distributes specific codes to permitted researchers (B. Zarate, NJ Fish and Game, pers comm.). Likewise, the USFWS distributes codes to researchers working with Mojave desert tortoises (R. Averill-Murray, USFWS, pers comm.).

Figure 1. A preferred marking scheme for turtles



Note: The 1-2-4-7 system is illustrated, using drill hole marks in the marginal scutes of a turtle. From using only the 16 scutes labeled with numbers, a total of 9,999 uniquely marked turtles may be identified. The carapace marginal scutes may either be marked by notching or by drilling holes with small sterilized drill bits.

Source: Buhlmann, K.A., T.D. Tuberville, and J.W. Gibbons. Turtles of the Southeast. University of Georgia Press, Athens, GA. 252p.

In theory, hatchlings produced at approved captive-breeding facilities would not need to be individually marked, but that might depend on the species in question. The rarity, value, and numbers of certain species in trade may make individual marking important for some species, with benefits to both people involved in the trade and enforcement agencies alike, but marking numerous relatively common, lower-value species—such as red-eared sliders (*Trachemys scripta*), reared by the thousands on a Louisiana turtle farm—would be an unnecessary regulatory burden, some workshop participants noted.

In summary, marking turtles involved in trade or research, either by shell notching or PIT tags, may serve as a valuable trade-monitoring and species-protection tool, if their markings and the codes used by researchers to mark them are coordinated among state/provincial wildlife agencies, personnel in wildlife trade law enforcement, and, potentially, UMAs in Mexico. The benefits from this coordinated marking could be described as follows:

1. Marking turtles in trade could protect legally operating commercial dealers.
2. State wildlife agencies that coordinate marking efforts would be able to identify and confiscate turtles that are discovered in illegal trade, thus enabling the turtles to be returned to conservation breeding situations or returned to the wild, if deemed appropriate.
3. Coordination could allow for identification—to the exact locality where poached—of confiscated, illegally smuggled, poached wildlife. Turtles that are confiscated could have a greater likelihood of being returned to their correct wild habitat or used for captive breeding, where the offspring can be returned to the parents' original habitat. Options for a return to wild habitat are currently often limited; the options now available to law enforcement, for seized specimens, include placement in nature centers, placement in universities for research, and euthanasia.
4. Identification of the locality of poached turtles may make it more likely that enforcement personnel can hone in on the operating areas of poachers and make apprehensions. Research that enables genetic identification of confiscated wildlife to source localities could be funded, and the results used to complement identification by physical marking.

4.10 Four-inch Rule for Domestic Sale

During the workshop, the facilitator and experts provided information on the four-inch rule. This information is included in this report as reference information. In May 1975, the US Food and Drug Administration banned the sale of turtles under four inches in size (Code of Federal Regulations Title 21 CFR 1240.62). This was because hatchling turtles can be carriers of *Salmonella* bacteria. The catalyst for *Salmonella* infection is usually unclean conditions in the aquarium in the captive environment, usually as a result of rotting food (meats), feces, and lack of proper filtration. The contamination is easily transmitted to children if they handle the pets and then touch their mouth or food without washing their hands. In 1975, when the ban was enacted, hatchling turtles were found abundantly in US pet stores and were inexpensive pets. Parents purchased many of them for their children, with very little understanding of care and husbandry. Subsequently, most of those thousands of hatchling turtles died, and some were released into inappropriate wild environments, where they have caused invasive problems.

Banning the domestic sale of hatchling turtles in the United States has likely prevented many hatchling turtles from dying, and prevented *Salmonella* infections in children. However, the domestic ban on the sale of hatchling turtles does not extend to exports for international trade. Thus, many turtle farms continue to conduct legal trade in common species, and ship to international markets, in particular to countries with high demand (e.g., China). With regard to some of the 12 priority species listed in the CEC Turtle Action Plan (CEC 2017), captive breeding of those species and concomitant rearing to a larger size (i.e., greater than four inches) would presumably allow permitted captive-breeding facilities to sell those larger, captive-reared turtles in the domestic market. Because breeders would need to invest more time and resources in rearing those turtles, the prices would be higher (the turtles would no longer be a throw-away pet) and those people purchasing these turtles would likely be prepared to employ better husbandry, thus resulting in less risk of *Salmonella* and other issues.

The requirement to rear juvenile turtles to a size greater than four inches might also address a conservation conundrum: that is, it is easy for poachers to illegally harvest adult turtles from the wild because the adults are generally abundant, in healthy populations, and can be trapped or caught. But it is not as easy to encourage captive adult turtles to nest successfully in captivity. Hatchling turtles can

be obtained illegally by poaching turtle nests. But, most importantly, juvenile/sub-adult-sized turtles are difficult to poach because they are generally more secretive in the wild and are less abundant in any given population, and they could only be produced abundantly in legitimate captive-breeding situations through head-starting. Thus, if members of that age class could be certified as captive-reared, it would give financial benefits to breeders and presumably result in a reduction of poaching and illegal harvesting of both adults and eggs from wild populations. Allowing captive breeding will allow breeders to rear (head-start) hatchlings to the four-inch minimum, thus permitting domestic trade (in the United States and Canada) and perhaps discouraging collection from the wild.

4.11 Confiscations

It is commonly presumed that illegally trafficked wildlife represents adult animals that have been poached from wild populations. The life-history data presented in this workshop were intended to make clear for resource managers and policy regulators that harvest of even a few adult turtles removed from any wild population puts that population either at risk of decline or clearly on the path towards extirpation (Spencer et al. 2017). It is important to mention that many confiscated adult turtles cannot be easily or safely returned to the wild. A suggestion would be to make those confiscated turtles available for legitimate conservation/recovery projects that *eventually* benefit wild populations of threatened turtle species. Even if it is agreed that the confiscated individuals themselves cannot be returned to the wild, it may be possible, with appropriate genetic analyses, to return their captive-bred offspring to near- or exactly correct ecological localities.

Workshop participants addressed that confiscated specimens may be taken from private possession of the trader by the government, based on its legal authority to enforce existing laws, and become property (or ward) of the government. However, even though storing confiscated preserved specimens in warehouses or lending them for educational purposes is relatively simple, dealing with confiscated live specimens might be more complicated, due to the ongoing need for care and facilities. Participants mentioned that governments can be pragmatic and place live animals in zoos or other facilities, possibly including private collections in some cases, but this creates potential uncertainty about the ownership of the specimens over the long-term and especially the ownership of any offspring produced in captivity, particularly when parents included a mix of legally obtained, privately-held and confiscated specimens. In addition, any possible commercial trade in such offspring creates further regulatory complications that need to be addressed.

Workshop participants were in agreement that they did not condone transfer of confiscated turtles back into the possession of individuals who might once again put them into commercial trade for personal profit. Legitimate conservation organizations that are able to provide conservation and species recovery benefits through confiscated animals should be identified. Species that are rare or threatened in their state, province, or country of origin should not be destroyed after confiscation by enforcement agencies. However, enforcement personnel cannot be expected to care for all confiscated animals. Thus the development of partnerships is critical. It is imperative that there be a stepwise process developed to deal with this abundance of confiscated wildlife. Disposal of confiscated CITES-listed live specimens is guided by Resolution 17.8 (<https://cites.org/sites/default/files/document/E-Res-17-08.pdf>), and the importance of placing live turtles in suitable rescue facilities was emphasized in Notification to the Parties 2011/029. There are examples of where this is already occurring (see, e.g., Turtle Survival Alliance, <www.turtlesurvival.org>).

Placement of confiscated turtles could be made with organizations that would maintain them in assurance colonies (i.e., viable populations maintained in captivity to preserve future species recovery options). Alternatively, confiscated turtles might be assigned to certified captive-breeding facilities, where they perhaps could build the breeding stock, and offspring produced might be returned to the wild. Perhaps breeders could be provided with incentives to produce offspring for conservation goals. Further guidance from CITES regarding confiscations includes the following:

1. Resolution Conf.17.08: *Disposal of illegally traded and confiscated specimens of CITES-listed species*.
    a. Annex 1 with Decision Tree for disposal of live animal specimens
    b. Annex 3 with Guidelines to develop Action Plans
2. Notification 2009/009: *Confiscation of live animals: List of sources of assistance provided by the Species Survival Network*
    a. Link to an online list of rescue centers
3. Notification 2011/029: *Disposal of confiscated live tortoise and freshwater turtle specimens* emphasizes the often high conservation value of confiscated turtles and provides guidance on resources for rescue and placement.

Observations about confiscations that were shared by workshop participants include the following:

1. Turtles that are confiscated often die in custody.
2. Turtles are often euthanized because facilities and resources for placement are limited, appropriate facilities and partnerships are unknown, and resources to distribute are lacking—thus the necessity to promote partnerships.
3. There are limited resources to house turtles while compliance is verified or the prosecution procedures are completed.
4. Confiscated turtles must not be given to individuals who may seek to return these same animals to the trade, or even return the offspring to the trade.
5. Confiscations might be used to build conservation-focused assurance-colony populations. This requires confirmation; agents are busy enforcing the law, so a formal proposal would have to go through legal services.
6. Confiscations can be analyzed genetically to obtain basic origin information, if funding can be made available.
7. Funding may be required to help agencies, partners, and individuals hold these confiscated animals for conservation benefit.
8. Offspring can in theory be used to bolster, augment, or re-introduce species.
9. Collaborations and discussion are required with state and federal agencies in Canada, Mexico and the United States.

4.12 Sustainable Trade versus Sustainable Harvest

Sustainable trade of the 12 priority turtle species from captive-breeding operations may be possible if established source stock is acquired from sources other than the wild (i.e., confiscations, or compiled from other collections of long-term captive animals). Sustainable harvest (from the wild) may be achievable if only a percentage of eggs and hatchlings are collected from wild populations (with an NDF) and some of those hatchlings are made available for trade but a portion are also used to enhance/supplement the same wild population. Wild collection of adult females will not result in sustainability. US researchers that attended the workshop suggested that the focus could be placed on the percentages of eggs, hatchlings (yearlings), and perhaps in rare cases juveniles (i.e., not yet reproductive). However, emphasized that it is imperative that the impacts of harvest to a population be well understood.

4.13 Public Awareness

Raising public awareness about wildlife trade can take many paths. During the workshop, participants identified the need to raise consumer community awareness, the feasible ways/strategies listed below:

1. CITES identification manuals are available online to help law enforcement identify turtles in trade: <https://www.cites.org/eng/resources/publications.php>.
2. Messages need to reach out to the publics' emotions—for example, most people like turtles. Thus, turtles should be an easy organism for which to garner public support and empathy.
3. CEC might consider creating a logo, a single sentence, and a common message.
4. The Monarch Butterfly CEC awareness campaign should be used as a model. The decline in monarch butterflies has triggered interest in this species in all three countries, because: a) populations are seen across all three countries, and b) there are things people can do to help conserve monarchs; for example, people can manage their small plot of garden or yard and see the benefits when the butterflies arrive.
5. Other conservation groups can help with turtle messaging (e.g., Partners in Amphibian and Reptile Conservation [PARC], Turtle Survival Alliance [TSA]).
6. Specific species messaging is possible; e.g., for *Dermatemys* and local communities in cooperation with UMAs in Mexico.

Clemmys guttata (Spotted Clemmys), Kurt A. Buhlmann

5. Law Enforcement Information

5.1 Overview

During the workshop, law enforcement officials from Canada, Mexico, and the United States held closed-door sessions to discuss trade issues. Their discussions included four broad topical objectives (Table 7, and section 5.2), for which they shared a summary with the participants. All workshop participants were taken on a field trip to the USFWS offices at the Port of Miami for presentations on how import/export inspections occur and on the issues related to illegal trade in wildlife.

Table 7. Law enforcement session objectives

1. Highlight the problem of illegal turtle and tortoise collection and trade.
2. Identify training, information, and resources needed for appropriate investigative and enforcement actions to detect and respond to illegal turtle and tortoise trade and to protect wild populations. Thus, build enforcement capacity.
3. Assess and make recommendations to improve enforcement, compliance, and intelligence-sharing collaboration between countries, states/provinces, and state/provincial and federal enforcement authorities (state-state collaboration and federal-state collaboration).
4. Establish a list of variables for measuring project outcomes (e.g., indicators to evaluate enforcement action outcomes).

5.2 Port of Miami Visit

Lessons learned from the visit to Port of Miami
Adaptive management implications for conservation, management, and enforcement

Overall, the visit to the Port of Miami continued to highlight the problem of illegal turtle and tortoise collection and trade. Summary points are as follows:

- There is massive legal and illegal trade with Asia.
- There is the possibility of organized crime being involved in the illegal traffic of species.
- Sometimes regulations for legal trade can be overbearing and create disincentives.
- Overall, 80% of wildlife trade is commercial. The Port of Miami is a big port of entry, as are several others, including Los Angeles. Other ports will be designated, including Savannah and Norfolk, to accommodate expanding wildlife trade and front-line interdiction efforts.
- Priority species for USFWS inspectors include Endangered and Threatened species, CITES species, migratory birds, and marine mammals (e.g., walrus, sea otter, manatee).
- With Executive Order 13648, the United States has made combating wildlife trafficking a priority, because illegal wildlife represents an international crisis that continues to escalate.

- Workshop participants learned about items that are commonly imported or smuggled. Examples included elephant ivory, tarantulas, and boas. Wildlife is imported commercially into the United States for many reasons: 1) commerce (pet trade), 2) scientific use, 3) personal use, and 4) exhibition in circuses, zoos, and aquariums.
- Illegal trade results in significant increase in the value of the species in trade, progressively, as it passes from people collecting the species to intermediaries to exporters.
- Discoveries of new species and listings on CITES may drive a market because of perceived rarity.
- Workshop participants learned about efforts by agents to track down illegal exportation of wood turtles, one of the workshop's priority species. The network of smuggling and illegal activity included Pennsylvania, Louisiana, California, and Hong Kong, and involved joint efforts in those places.
- Workshop participants were provided with example CITES export permits.

A discussion topic that followed the Miami Port visit was based on data interpreted from the CITES export permits used as examples with the workshop participants. Specifically, data entered in Box 9 of the CITES Export Permit are critical data for assessing the impact of trade and for formulating NDFs. These data are not available in CITES or in LEMIS reports because they are not digitally captured and may only be available on paper documents, which may be discarded after 3–4 years.

For example, on four export permits for spotted turtles, wood turtles, Blanding's turtles, and Eastern box turtles, respectively, Box 9 reported:

- Export: Live; 0.0.50; hatched June to July 2017; carapace length up to 8 cm
- Export: Live; 0.0.112; hatched April to June 2017; carapace length up to 8 cm
- Export: Live; 0.0.125; hatched September 2017; carapace length up to 8 cm
- Export: Live; 0.0.12; hatched August 2017; carapace length up to 8 cm

The information presented above is used to help formulate NDFs. For example, the turtles were hatched in captivity in 2017 and had grown up to 8 centimeters (cm) by the time of export in 2018. The CITES data in Box 9 can be linked to the available information on turtle life histories, for which clutch sizes are: spotted turtles: 2–4; wood turtles: 5–10, Blanding's turtles: 8–12, Eastern box turtles: 3–5. Females only produce one clutch per year. Thus, it can be estimated how many captive females produced these offspring.

The USFWS reprsentative mentioned that the Service seeks improvements in its abilities to identify illegally sourced turtles/tortoises in trade, such as through the use of turtle-marking systems. In addition, USFWS aims to identify partners to use confiscated turtles and tortoises for conservation purposes, such that enforcement has positive feedback on conservation and species viability.

Based on the workshop discussion on the types of data present in Box 9 of the CITES Export Permit, the recommendation made is that data should be preserved, in order to assist with inferences about hatchling vs. adult numbers; age classes; and market value.

5.3 Law Enforcement Closed-door Session

The law enforcement (LE) officers shared overall thoughts with workshop participants after their closed-door session. In summary, major points that were reiterated are as follows:

- There are few inspectors, overall, and not all shipments can be opened and visually inspected.
- Identification materials and training assistance are needed, particularly for turtle identification.
- Keeping paperwork simple helps to promote compliance.
- The diversity of animals inspected is great, thus the ability to have expertise to identify all species is challenging.
- There are questions regarding the handling of confiscated turtles (LE needs dedicated facilities for handling and holding confiscated turtles).
- To determine populations of origin there is a need for range-wide genetic mapping of each species, with dedicated funding, as part of confiscations management.
- LE tracks confiscated and released animals through the "chain of custody."
- There is desire to ensure confiscated animals have conservation value for their species.
- Further discussions are needed to assess the value in recording illegal trade data.
- Sharing of data on what is being confiscated is needed.
- Help that biologists or institutions can provide with confiscations should be assessed.
- Understand that some countries treat confiscations differently. For example, Canada sends confiscatons back to the country of origin.

Gopherus agassizii (Desert tortoise), Kurt A. Buhlmann

6. Conclusions and Recommendations from the Workshop

Workshop participants were divided into four groups, one per country (Canada, Mexico and United States), and an additional group of scientists from the United States, to address the following question:

Given what we have heard at this workshop, provide your major recommendations to promote turtle sustainable trade and conservation.

The results of the break-out session are summarized below, per each group.

6.1 Canada

Canadian participants identified the following major concepts as important for further discussion:

- Highlighted the need for evaluating the current restriction associated with commercial imports of turtles under the Health of Animals Act and the Health of Animals regulation, which is implemented by CFIA. This restriction was enacted several decades ago to prevent the transmission of *Salmonella*. The group suggested that this restriction could be re-evaluated and that further discussions with CFIA were necessary, including on the determination of restrictions.
- Suggested that the public should be better informed about the current restriction.
- Identified the need for a wider distribution and promotion of the CEC's work on sustainable trade: to be extended to NGOs, zoos, other government entities, and conservation stakeholders.
- Proposed that a multi-stakeholder workshop could be useful, and priority topics could include turtle trade, management, and conservation within Canada.
- A national strategy to determine how seized specimens should be handled, their final destination, and conditions for release for conservation purposes was also identified as necessary for the management of confiscated turtles.
- Data gaps (e.g., in life history) of the priority species were identified.

6.2 Mexico

Mexican participants outlined their recommended actions by session topic:

Conservation

- It is necessary to compile, develop and share any ecological and biological information on the priority species.
- Develop better outreach tools promoting turtle conservation.
- Include specific conservation actions in management plans of natural protected areas.
- Develop additional studies on *D. mawii*, such as pilot re-introduction projects encouraging UMAs, and determination of critical habitat and nesting areas for species native to Mexico.

Management

- Develop *in situ* protocols for breeding and to define and re-inforce production lines via UMAs (as orientation to the general public, who wanted to establish a UMA managing turtles).
- Better define criteria for NDFs (especially in quick assessments, as NDFs can be requested once the harvest is done).
- Carry out participatory surveillance of breeding facilities; diversified projects for production under UMAs might be necessary. Even though better social communication and UMAs would cost money, they would have a direct, large benefit on *D. mawii*.

Enforcement

- Develop better identification materials for species, and potentially a training workshop for the identification of turtles, including other species not necessarily listed in CITES appendices but which are implicated in high trade interest and concerns that overexploitation could lead to declines.
- Identify illegal activity and conduct seizures quickly.
- Develop better protocols for potential release of turtles.

6.3 United States

United States government and state agency participants identified the following major concepts as important for further discussion:

- Develop communication strategies to assist in compliance and promote citizen science. Such communication strategies would also promote conservation efforts and raise awareness of the negative aspects of illegal collections and trade. Communication would begin directly with law enforcement for measures and methods to minimize illegal trade.
- Identify best management practices (BMPs) for commercial farms and breeding facilities. For example, ask the pet industry to develop a survey of recognized captive-breeding facilities, at a national and international level, as well as develop a scheme or code of ethics and accountability for captive breeding. The survey would query industry to determine which turtle species are currently bred for production.
- Draft and adopt best management practices for breeding turtle species, particularly for the priority species. These BMPs would include measures such as marking for traceable trade, and maintenance of stock records. Along with the BMPs a certification scheme for turtle breeders, that represents a code of ethics, and promotion of legal trade will be necessary.
- Compile life-history and biological information to assist in the determination of breeding/production capacity and to assist with determining the level of reproduction necessary to maintain sustainable wild populations.
- Seek more-unified and consistent laws among state agencies that have governance over turtles.
- Each state/province should gather further information on populations and monitoring efforts.

6.4 Scientists

- Proposed that the certification of captive-rearing facilities would be necessary for certain species, in addition to the development of best management practices (BMPs).
- Highlighted the need to raise awareness that life-history and husbandry needs of some species are not compatible with commercial farming. If those hard-to-breed-in-captivity species are rare species, the regulatory agencies need to be aware that individuals of those species will be poached from the wild.
- Regarding the wild harvest, the US scientists urged that no adults should be collected from the wild except in special, highly regulated circumstances.
- Improved communication is needed, especially with the public, concerning turtle declines and conservation. Part of the communication message would be the need to develop CITES-approved protocols for repatriating or re-introducing confiscated turtles. Also, there is a need to strengthen the network of rescue and release facilities, so that they do not become overburdened with turtles. However, a clear repatriation and re-introduction protocol would alleviate issues.
- Additional information is needed on range-wide genetic profiling of the priority species to assist with repatriation and re-introduction efforts of confiscated turtles. The profiling could also be used to determine at minimum from what region or state a turtle originated initially. In addition, an inventory of all captive turtles used in captive breeding and trade in Mexico and the United States is necessary, which will likely require effort and support from the state agencies which would query breeders.
- An updated analysis of species trade trends is necessary.
- Continued biological research on priority species is needed, aimed at evaluating the factors which increase population growth rates, to promote wild population recovery and potentially lead to sustainable wild take.

6.5 Summary of Workshop Themes and Recommendations

6.5.1 Life-History Challenges

Turtles, as a group, have a suite of life-history traits that are characteristic of slow-to-mature, long-lived organisms. Turtles have delayed sexual maturity, meaning that they first put many years of growth into developing a strong shell that will help ensure their survival. Once adults, they are able to invest energy in reproduction. Adults therefore can be expected to live for many years, whereas hatchlings and juveniles have much lower survivorship. Population stability in wild, viable populations depends on adult survivorship remaining high.

Turtle populations can survive—and later recover from—multiple years without juvenile recruitment (Spencer et al. 2017) but if the adult mortality suddenly increases, as may be attributable to automobile mortalities or collecting for the pet and food trades, then those populations can quickly be on a trajectory to extirpation. In short, this complicates their population management, conservation, and recovery.

Chelonians (turtles) are often quick to respond to perturbations and slow to respond to recovery efforts. Therefore, the quotes, "turtles are quick to decline, slow to recover" and "hatchlings are ephemeral; but adults are like rocks on the landscape" were discussed during the Workshop.

In summary, turtles:

1. are resilient to high levels of nest predation for sustained periods;
2. require only periodic intervals of juvenile recruitment and of low levels of nest predation to maintain population viability; and
3. can be driven to extinction in populations that undergo escalating levels of adult mortality.

Thus, the conclusion is that harvest of adult turtles from these wild populations may not be sustainable and therefore is not recommended.

6.5.2 Suggested Criteria for NDFs

Overall, the workshop participants understood that non-detriment findings (NDFs) should only be conferred when it is sure that the export(s) of the turtles will not negatively affect the survival of the species in the wild. A recommendation from the workshop was that the determination of NDFs should consider the volume of trade (both legal and illegal) in the species when evaluating the species' vulnerability.

6.5.3 CITES Data Improvements

Workshop participants studied CITES export permits and recommended that distributed permits be preserved in computer databases.

6.5.4 General Trade Trends and Value of Turtles in Trade

Biology and rarity have effects on trade trends. For example, high-fecundity species undergo wide price fluctuations, while low-fecundity turtle species tend to be subject to more stable (higher) prices. As the rarity and higher levels of endangerment rise, so does market value. It has been argued (Nadal and Aguayo 2014) that wildlife-trade price trends do not follow traditional economic models for commodity prices, but have more in common with the investment art market, where personal preference and prevailing fashions result in fluctuating prices. The workshop participants discussed the need for increased law enforcement commensurate with additional CITES listings.

6.5.5 Supporting Traceable Trade

Traceable legitimate wildlife trade, as well as documentation of legitimate conservation organizations, may ultimately require that individual turtles of the 12 priority species be uniquely identifiable. The workshop presented information about marking techniques long used in scientific field studies for unique and permanent identification. The workshop participants discussed and seemed to be in consensus that marking of turtles by various methods would help law enforcement.

6.5.6 Placement of Confiscated Turtles

Confiscated turtles should not be placed with persons who would financially benefit from the turtle's commercial value. Workshop participants deliberated about whether confiscated turtles should be made available to legitimate conservation organizations that can use these turtles directly or indirectly to benefit wild populations.

6.5.7 Public Awareness

A clear message on turtle declines and conservation needs to be developed and communicated. Further examination to identify target audiences is needed. Workshop participants recommended seeking further guidance from organizations or individuals who could help with marketing messages.

6.5.8 Enforcement Assistance for Mexico

Mexico seeks to increase the transfer of information to assist with enforcement, management, and conservation. Sharing as much information as possible may help stop the illegal trade. In Mexico, nearly all legally exported turtles are *Dermatemys mawii* and *Gopherus berlandieri*.

6.5.9 Experimental Harvesting Studies

Workshop participants discussed determining if a proportion of hatchling diamondback terrapins (*Malaclemys terrapin*) might be harvested from protected nests in the wild, and suggested this may warrant a pilot study. The underlining premise of this study was that a known increasing wild population of diamondback terrapins was available. The adult turtles have been protected from being harvested in crab pots through use of an excluder device (Wetlands Institute 2019) and the nests produced by the females in this population were not consumed by mammal predators because the nesting site was on an island. Given this knowledge, it may be possible to allow—under controlled conditions—the partial harvest of select nests for commercial trade, in conjunction with monitoring of the overall population for continued stability. A study of this type may help in understanding how sustainable harvest and trade of wild turtles could be possible. The workshop participants seemed to be in agreement that a pilot study of this type should be prioritized.

6.5.10 Captive Facilities for Commercial and Conservation Recovery

For *Dermatemys mawi*, captive domestic facilities exist in Mexico that can be managed as UMAs by local communities. First, commercial-harvest turtles could be reared to a certain size in captivity to ensure higher survival when released. This program could be operated in a few rivers, as a put-and-take fishery. The genetics of these harvested populations would be unimportant, as they are for human consumption, not species conservation. Second, recovery of viable protected populations in a few river systems is highly desirable. Surveys could identify several river systems that have declining wild populations. These populations could be supplemented by eggs that are retrieved from the wild and hatched in the farms, and the juveniles raised to older/larger sizes. These turtles could then be repatriated to streams where declines have occurred, to rebuild viable populations. These rebuilt populations would not be harvested, and it would be important to keep genetic records of the stock used for boosting these protected wild populations. The workshop participants were supportive of this strategy.

6.5.11 Cooperation

One of the main objectives of the workshop was to provide recommendations to improve current management and regulatory regimes and identify measures to strengthen the conservation and the sustainable use and trade of freshwater and terrestrial turtles. Through this workshop, the CEC sought to improve trinational cooperation to support the legal, traceable and sustainable trade of the twelve priority species.

In the United States, for example, greater cooperation among states may lead to more-comprehensive policies for trade in species that have geographic distributions across state boundaries (Mali et al. 2014; Nanjappa and Conrad 2011). Workshop participants who represented states and provinces were supportive of bringing this understanding to their home agencies.

Mexico asked for supplemental information regarding identification materials and opportunities for collaborative research leading to sustainable turtle trade. Workshop participants recommended the production of materials on turtle identification and management.

Overall, the workshop highlighted the opportunities for and benefits of collaboration among the three countries.

Resources

Arizona Ornate Box Turtle Fact Sheet
<www.azgfd.com/wildlife/nongamemanagement/turtle/ornate-box-turtle/>

Canada – Wild Animal and Plant Protection and Regulation of International and Inter-provincial Trade Act
<www.canada.ca/en/environment-climate-change/services/environmental-enforcement/acts-regulations/wild-species-protection.html http://laws-lois.justice.gc.ca/PDF/W-8.5.pdf>

CEC Project website: Sustainable Trade of Priority Species
<www.cec.org/our-work/projects/supporting-sustainable-trade-cites-species>

CEC Turtle and Tortoise Action Plan
<www.cec.org/islandora/en/item/11699-sustainable-trade-in-turtles-and-tortoises-action-plan-north-america-en.pdf>

CEC Trinational CITES Website <www.cec.org/trinational_cites>

CITES Website <https://cites.org>

CITES AC28 Doc. 15 [Guidance for Non-Detriment Findings for Turtles]
<https://cites.org/sites/default/files/eng/com/ac/28/E-AC28-15-Annex2.pdf>

COSEWIC Listed Species
<www.canada.ca/en/environment-climate-change/services/committee-status-endangered-wildlife.html>

FWS CITES Webpage <www.fws.gov/international/cites/>

Partners In Amphibian and Reptile Conservation (PARC) <http://parcplace.org/>

Southeast Partners In Amphibian and Reptile Conservation (SEPARC) <http://separc.org/>

Northeast Partners In Amphibian and Reptile Conservation (NEPARC)
<http://northeastparc.org/>

Turtle Survival Alliance (TSA) <https://turtlesurvival.org/>

Association of Fish and Wildlife Agencies (AFWA)
<www.fishwildlife.org/afwa-inspires/partners-amphibian-reptile-conservation>

IUCN Guidelines for Reintroductions and Other Conservation Translocations
<https://portals.iucn.org/library/efiles/documents/2013-009.pdf>

IUCN Guidelines for the Placement of Confiscated Animals
<https://portals.iucn.org/library/sites/library/files/documents/2002-004.pdf>

IUCN Guidelines for the Management of Confiscated, Live Organisms
<https://portals.iucn.org/library/sites/library/files/documents/2019-005-En.pdf>

Clemmys guttata (Spotted turtle hatchling), Kurt A. Buhlmann

Annex A: Workshop Agenda

Trinational trade and enforcement training workshop to support the legal and sustainable trade in turtles/tortoises
Miami, Florida, United States
24–26 October 2018

The Action Plan for North America on Sustainable Trade in Turtles and Tortoises developed by the Commission for Environmental Cooperation (CEC) in 2017 includes priority actions identified by government experts from Canada, Mexico and the United States to support the sustainable trade of turtles/tortoises in North America.

As a follow-up and as part of the CEC's project, Supporting Sustainable Trade of CITES Species, this workshop will bring together researchers, managers and enforcement staff from Canada, Mexico and United States to share information about freshwater turtle and tortoise science and trade for 12 priority species (Table 1) and will help support the implementation of the Action Plan.

This workshop seeks to understand the ecology and life-history traits of turtles, recognize the challenges presented by trade (both pet and meat trade), identify research and management needs to help achieve sustainable trade and maintain viability of wild populations in North America, develop or revise policy for achieving turtle conservation, and revise a priority species list, as determined by the participants.

Table A1. Priority species included in the Action Plan for North America on Sustainable Trade in Turtles and Tortoises

12 Priority Species		Scientific Name	Range
Aquatic/semi-aquatic	Spotted turtle	*Clemmys guttata*	CAN, US
	Central American river turtle	*Dermatemys mawii*	MX, Belize & Guatemala
	Blanding's turtle	*Emydoidea blandingii*	CAN, US
	Wood turtle	*Glyptemys insculpta*	CAN, US
Terrestrial	Mojave Desert tortoise	*Gopherus agassizii*	US
	Texas tortoise	*Gopherus berlandieri*	MX, US
	Sonoran Desert tortoise	*Gopherus morafkai*	MX, US
	Gopher tortoise	*Gopherus polyphemus*	US
Brackish-water species	Diamondback terrapin	*Malaclemys terrapin*	US (Bermuda)
Semi-terrestrial	Eastern box turtle	*Terrapene carolina*	CAN, MX, US
	Spotted box turtle	*Terrapene nelsoni*	MX
	Western box turtle	*Terrapene ornata*	MX, US

Objectives of the workshop are as follows:

General

1. Share information on ecology, biology, conservation and management experience, science to promote sustainable use, law enforcement issues and strategies regarding trade of the 12 priority species of turtles/tortoises to support CITES implementation.
2. Discuss methods that could result in the reduction of unsustainably and/or illegally sourced specimens, and influence market demands and supply.
3. Support development of policies and actions that promote the recovery, sustainable use and conservation of wild populations—by offering new alternatives.
4. Promote legal, sustainable, and traceable trade.

Conservation

5. Discuss the ecological status of the 12 priority species included in the Action Plan, considering distributional occurrence, population status, life history traits (especially reproductive biology, age at maturity, survivorship).
6. Identify threats (in addition to trade) to the species.
7. Identify research and knowledge gaps and potential strategies to address them.
8. Discuss implications for life history from the wild harvest of these species and discuss the sustainability of current harvest levels.
9. Identify key elements for formulating non-detriment findings (NDFs) for these species.
10. Discuss captive breeding, ranching, and farming of turtle/tortoise species, and the opportunities/adverse effects of these activities on the conservation and sustainable use of wild populations.
11. Make recommendations on conservation measures, especially those "outside the box," that could lead to sustainable trade and guarantee viability of populations in the wild.

Management

12. Share understandings of existing trade (import/export) information sources and databases from state/provincial agencies, national (including, e.g., Endangered Species Act, Species at Risk Act, NOM-059), and international (CITES).
13. Discuss current strategies and regulations that apply to Canada, Mexico and the United States, and their effectiveness for turtle/tortoise conservation.
14. Make recommendations to improve current management and regulatory regimes and any measures needed to strengthen understanding of the level and effects of trade on the conservation/sustainability of freshwater and terrestrial turtles.
15. Identify management actions that will promote recovery, conservation and sustainable use of wild populations.
16. Consider raising consumer community awareness and define the most feasible ways/strategies to accomplish doing so.

Law Enforcement

17. Highlight the problem of illegal turtle/tortoise collection and trade.
18. Identify training, information, and resources needed for appropriate investigative and enforcement actions to detect and respond to illegal turtle/tortoise trade and to protect wild populations. Thus, build enforcement capacity.
19. Assess and make recommendations to improve enforcement, compliance, and intelligence-sharing collaboration between countries, states/provinces and between state/provincial and federal enforcement authorities (state-state collaboration and federal-state collaboration).
20. Establish a list of variables for measuring project outcomes (e.g., indicators to evaluate enforcement action outcomes).

Workshop format

	Morning	Afternoon	
Day 1, Wednesday, 24 October	Introductions & Turtle Ecology and Life History session	Conservation Strategies session	Law Enforcement closed session
Day 2, Thursday, 25 October	Field visit: Port of Miami	Management Review session	
Day 3, Friday, 26 October	Management Actions session	General conclusions	

Detailed agenda

Day 1	Wednesday 24 October 2018
9:00–10:30	Workshop opening and introduction to CEC (5 min.) **Georgina O'Farrill**, CITES Project Lead, Commission for Environmental Cooperation Welcome remarks (10 min.) **Rosemarie Gnam**, Chief - Division of Scientific Authority - International Affairs; US Fish and Wildlife Service CEC project "Supporting Sustainable Trade of CITES species" (10 min.) **Georgina O'Farrill** Introduction and presentation of workshop agenda (15 min.) Workshop facilitator: **Kurt Buhlmann** Overview presentation on CITES & Turtles/tortoises (30 min.) **Rosemarie Gnam**, Chief- Division of Scientific Authority- International Affairs; US Fish and Wildlife Service Statistics and trends in international turtle trade for priority species (20 min.) **Thomas E.J. Leuteritz**, Chief- Branch of Conservation Science Policy, Division of Scientific Authority; US Fish & Wildlife Service Headquarters
10:30–10:45	Coffee Break
10:45–11:45	Conservation session (1 hour.) Presentation: State of knowledge of the ecology, population status, trade and life history traits of the 12 priority species included in the Action Plan (45 min. including question period) **Kurt Buhlmann**, University of Georgia; Peter Paul van Dijk, Global Wildlife Conservation and Mike Dreslik, University of Illinois *Facilitated discussion*; 15 min.

Day 1	Wednesday 24 October 2018 *(continued)*	
11:45–13:00	Facilitated discussion: Discuss implications on life history for the harvest of these species and the sustainability of current harvest levels, and identify key elements for formulating NDFs for these species; 60 min. *Conclusions*; 15 min.	
13:00–14:30	Lunch	
14:30–16:00	Conservation session; 90 min. Country presentations on how each country uses CITES source codes (captive bred, ranched, wild); 10 min. per country **Jacinthe Belec**, Intelligence Manager, Senior Wildlife Officer and Rachel Borrato, Intelligence Analyst; Wildlife Enforcement Directorate (Ontario), Environment and Climate Change Canada **Paola Mosig**, Coordinadora de la Autoridad Científica CITES; Conabio, Mexico **Jonathan Kolby**, Policy Specialist; Convention on International Trade in Endangered Species of Wild Fauna and Flora- US Fish and Wildlife Service USFWS Division of Management Authority Facilitated discussion: Discuss wild collection, captive breeding, ranching, and farming of turtle/tortoise species, and the opportunities/adverse effects of these activities on the conservation and sustainable use of wild populations; 50 min. *Conclusions*; 10 min.	
16:00–16:15	Coffee Break	
16:15–17:30	Roundtable discussion: facilitated by workshop facilitators; 60 min. Overall conservation recommendations on research needs (population studies, CITES listings, captive breeding, wild collection, ranching and farming programs) that would result in sustainable harvest and trade for the 12 priority species included in the Action Plan. Wrap up Day 1; 15 min. Key discussion points and presentation of Day 2 agenda (Field trip & Management issues); **Kurt Buhlmann**	Law enforcement closed meeting (2hr. 45 min.) Presentation: Trade in Turtles and Tortoises in Canada (Wildlife Enforcement Perspective); Wildlife Enforcement Directorate, ECCC – Observations on what is the trade in turtles in Canada. – What do we see at the borders and in domestic trade? Presentation: **Saulo Martinez**, Director de Sanciones; Procuraduría Federal de Protección al Ambiente; Profepa, Mexico **Main discussion points:** Highlight the problem of illegal turtle/tortoise collection and trade. Identify training, information, and resources needed for appropriate investigative and enforcement actions to detect and respond to illegal turtle/tortoise trade and to protect wild populations. Thus, build enforcement capacity. Assess and make recommendations to improve enforcement, compliance, and intelligence-sharing collaboration between countries, states, and between state/provincial and federal enforcement authorities. Identify next steps to ensure collaboration among state/provincial, national, and international agencies. Establish a list of variables which can be used to measure project outcomes (e.g., indicators to evaluate enforcement action outcomes Seek improvements on the abilities to identify illegally sourced turtles/tortoises in trade, such as through use of turtle marking systems. Identify partners to use confiscated turtles/tortoises for conservation purposes, such that enforcement has a positive feedback on conservation and species viability.

Day 2	Thursday 25 October 2018 – Visit Port of Miami/Management session
08:00–12:00	Visit to the Port of Miami (see attached document)
13:00–14:00	Lunch
14:00–16:00	Management Session: Country presentations to understand how each country manage and regulates the harvest and trade of species (federal vs state/provincial); 20 min per country **Sylvain Giguère**, Species at Risk Recovery Biologist (Quebec); Environment and Climate Change Canada **Antonio Bernal**, Subdirector de Gestión de Licencias, Registros y Aprovechamiento intensivo and Miguel Ángel Cobián, Subdirector de Comercio Nacional, Internacional y otros; Semarnat **Priya Nanjappa**, Program Manager, National Amphibian and Reptile; Association of Fish and Wildlife Agencies Presentation on confiscated turtles and how authorities/agencies handle this for conservation benefit; 20 min. **Kurt Buhlmann**, University of Georgia; Peter Paul van Dijk, Global Wildlife Conservation and Mike Dreslik, University of Illinois Roundtable discussion: facilitated by **Kurt Buhlmann**; 40 min. Evaluate information on state/provincial management, existing national (including, e.g., Endangered Species Act, Species at Risk Act, NOM-059), and international (CITES), strategies and regulations that apply to Canada, Mexico and United States, and their effectiveness for turtle/tortoise conservation. Share understandings of existing trade (import/export) information sources and databases (e.g., registers, data).
16:00–16:20	Coffee break
16:20–17:50	Roundtable discussion**:** facilitated by workshop facilitator; 90 min. Make recommendations to improve current management and regulatory regimes and measures needed to strengthen the conservation and the sustainable use and trade of freshwater and terrestrial turtles. For example, discuss opportunities to integrate management and enforcement to make confiscated turtles available to the correct authorities/agencies for conservation benefit [e.g., examples from Partners in Amphibian and Reptile Conservation (PARC) and Turtle Survival Alliance (TSA)]
17:50–18:00	Wrap up Day 2 (10 min.) Key discussion points and presentation of Day 3 agenda; **Kurt Buhlmann**

Day 3	Friday 26 October 2018 – General topics session
08:00–08:30	Coffee and light breakfast
08:30–10:30	Management session, 2 hrs. Roundtable discussion: facilitated by **Kurt Buhlmann** Establish a list of variables that can be used to measure project outcomes (e.g., indicators to evaluate enforcement action outcomes). Consider techniques to mark/identify legally traded turtles that can be used by law enforcement.
10:30–10:50	Coffee break
10:50–12:30	General topics session; 1hr. 40 min. Facilitated discussion: Lessons learned from visit to Port of Miami. Adaptive Management Implications for conservation, management, and enforcement**;** 60 min. Shared conclusions & next steps; 40 min
12:30–14:30	Lunch
14:30–15:30	Law Enforcement conclusions; 60min. General presentation from law enforcement officials to the workshop group; 30 min. Question and answer period; 30 min.
15:30–16:00	Meeting wrap up**;** 30 min.

Annex B: Workshop Participants

United States	
1	**Andrew Hutchinson,** - Office of Law Enforcement, Fort Myers Field Office, USFWS
2	**Brian Horne,** WCS (San Diego Zoo)
3	**Carolyn Caldwell**, Midwest Association of Fish and Wildlife Agencies – State of Ohio
4	**Cris Hagen**, Manager, Turtle Survival Center, South Carolina
5	**Cristina Jones**, State Turtle Biologist, State of Arizona
6	**Daniel Gaillard**, Partners in Amphibian and Reptile Conservation (PARC)
7	**Eugene Mathew Bendele**, Senior Special Agent–Attache, Mexico City; USFWS Office of Law Enforcement – International
8	**John Siemien**, Wildlife Biologist, UWFWS – Division of Scientific Authority
9	**Jonathan Kolby**, Policy Specialist – Convention on International Trade in Endangered Species of Wild Fauna and Flora, US Fish and Wildlife Service
10	**Kurt A. Buhlmann**, Senior Research Associate, University of Georgia
11	**Matt Elliott**, Assistance Chief – Wildlife Conservation, Georgia Department of Natural Resources
12	**Michael J. Dreslik**, Assistant Research Scientist, Illinois Natural History Survey, University of Illinois Urbana–Champaign
13	**Osborne (Buddy) Baker**, Chief of Wildlife Management – Coastal and Non-Game, Louisiana Department of Wildlife and Fisheries
14	**Peter Paul Van Dijk**, Director, Turtle Conservation Program, Global Wildlife Conservation
15	**Priya Nanjappa**, Director of Operations, Conservation Science Partners, Inc. Formerly Program Manager and PARC National Coordinator, Association of Fish and Wildlife Agencies
16	**Rosemarie Gnam**, Chief, Division of Scientific Authority, US Fish and Wildlife Service
17	**Thomas Leuteritz**, Herpetologist, Division of Scientific Authority, US Fish and Wildlife Service
18	**Willem Roosenburg**, Professor-researcher – Biological Sciences, Ohio University

Mexico	
1	**Ana Bertha Gatica Colima**, Professor-researcher, Animal Behaviour and Ecology Laboratory, Autonomous University of Ciudad Juarez (*Laboratorio de Ecología y Biodiversidad Animal, Universidad Autónoma de Ciudad Juárez*)
2	**Antonio de Jesus Garcia Bernal**, Deputy Director of Licensing, Registries and Intensive Management, Semarnat (*Subdirector de Gestión de Licencias, Registros y Aprovechamiento intensivo*)
3	**Carolina Carrillo**, Federal Inspector, Office of the Federal Attorney Environmental Protection (*Inspector Federal, Procuraduría Federal de Protección al Ambiente*)
4	**Claudia Elena Zenteno Ruiz**, Professor- researcher, Autonomous University of Tabasco (*Universidad Autónoma de Tabasco*)
5	**Francisco Soberón Mobarak**, Environmental Technical Coordinator, Protector of Wildlife and Ecology (*Coordinador Técnico Ambiental, Protectora de la Vida Silvestre y Ecología*)
6	**Gracia Gonzalez Porter**, Professor-researcher, Smithsonian National Zoological Park (*Parque Zoológico Nacional Smithsoniano*)
7	**Luis Guillermo Muñoz Lacy**, CITES analyst in implementation, Conabio (*Analista CITES en implementación*)
8	**Marco Lopez Luna**, Professor-researcher, Autonomous University of Tabasco (*Universidad Juárez Autónoma de Tabasco*)
9	**Miguel Ángel Cobián Gavino**, Deputy Director of National Commerce, International and others; Semarnat (*Subdirector de Comercio Nacional, Internacional y otros*)
10	**Paola Mosig Reidl**, Coordinator of the CITES Scientific Authority, Conabio (*Coordinadora de la Autoridad Científica CITES*, Conabio)
11	**Saulo Martinez**, Director of Sanctions, Office of the Federal Attorney Environmental Protection (*Director de Sanciones, Procuraduría Federal de Protección al Ambiente*)

Canada	
1	**Ernie Cooper**, Ernie Cooper Consultant, Inc.
2	**Philippe Drolet**, CITES Scientific Authority, Canadian Wildlife Service, Environment and Climate Change Canada
3	**Jacinthe Belec**, National Intelligence Manager, Wildlife Enforcement Directorate, Environment and Climate Change Canada
4	**Rachel Boratto**, Intelligence Analyst, Wildlife Enforcement Directorate, Environment and Climate Change Canada
5	**Sylvain Giguère**, Species at Risk Recovery Biologist (Quebec), Environment and Climate Change Canada

Glyptemys insculpta (Wood Turtle), Kurt A. Buhlmann

Annex C: Priority Species Summaries

C.1 Central American River Turtle (*Dermatemydidae*: *Dermatemys mawii*, Gray, 1847)

C.1.1 Biological Information

The distribution of the Central American river turtle ranges from extreme southern Mexico to Guatemala and Belize (Ernst and Barbour 1989). Ernst and Barbour compiled information on this species in 1989, and still little is known about the species' ecology and life history. Although the longevity of this species is unknown, it is known that females attain sexual maturity after 8 years. Females may lay up to two clutches per year, and clutch size of females from Tabasco averages 11 eggs. Females may reproduce annually, and the species has temperature-dependent sex determination (TSD), with lower egg-incubation temperatures producing males and higher temperatures producing females. Little is known about survival in the wild, and this precludes any estimates of long-term viability. There may only be 6–7 locations with viable populations, in three states in Mexico: 2 in Tabasco, 2 in Veracruz, and 2–3 in Chiapas (this workshop, pers comm.). Efforts are now being made to determine if genetic management is necessary and can then be used for conservation guidance.

C.1.2 Trade Data and Captive Breeding

Major trade exists between Guatemala and Mexico, but overall there is low international trade of *Dermatemys*. There is harvest for turtles in the wild for farming and domestic consumption, but little or no volume for the pet trade. The species has been considered a delicacy for as far back as the Mayan civilization and continuing to the present.

CITES Data Summary:

Between 2000 and 2015, 315 live *D. mawii* were exported from Mexico.
Between 2000 and 2015, 1,900 "specimens" of *D. mawii* were exported from Mexico.

LEMIS Data Summary:

Between 2000 and 2016, the United States imported:
881 GM (scientific samples, gms), 36 KG (presumably meat, kgs), 13 LBS (presumably meat, lbs),
696 Live (number of live turtles)

A turtle farm in Tabasco reportedly held about 800 individual *Dermatemys*, but lacked a management plan (Vogt et al 2011). Unfortunately, most of the turtles in farms are likely of unknown/undocumented origin or were originally harvested from the wild (workshop info, pers comm.). *D.mawii* juveniles can grow rapidly in captivity under appropriate husbandry conditions (Vogt et al. 2011) and can reach consumption size in 2 years and adult size in 8 years. Captive breeding may result in *Dermatemys* being a sustainable food source, thus alleviating the pressure on wild populations. UMAs could be developed to represent two production lines, one for re-introduction and the other for trade/consumption. Additionally, there is good communication with captive breeders, and such effective communication will be essential for the trade and conservation of the species and can result in traceable trade, which can then give a return benefit to conservation.

C.1.3 Data Gaps and Needs

Much of the ecological and life-history data necessary to delineate population viability in the remaining populations are missing for the species. Direct ecological studies are needed to assess natural reproduction. A focal study could target nest success and variation in clutch sizes. Such studies could be coupled with mark/recapture efforts to examine growth rates, ages and size of sexual maturity, and potentially generate age estimates. Finally, targeted radio-telemetry efforts on known age/staged individuals could begin to provide critical estimates of survival rates.

Also, the use of genetic management for the wild populations may be necessary. Surveys could identify several river systems that could have had or do have declining wild populations. These populations could be supplemented by eggs that are retrieved from the wild and hatched, and the juveniles raised in the farms to older/larger sizes. These turtles could then be repatriated to streams where declines have occurred, to rebuild populations and provide some sustainable harvest for local communities through a put-and-take harvest model. Although the genetics of the harvested populations would be unimportant, it would be essential to understand the genetics of the breeding stock used for augmenting protected wild populations.

C.2 Wood Turtle (*Emydidae: Glyptemys insculpta*, LeConte, 1830)

C.2.1 Biological Information

The wood turtle's range encompasses portions of Canada and the United States, from Nova Scotia south to Northern Virginia and west through New York, southern Ontario and the Great Lakes Region into extreme northeastern Iowa (Ernst and Barbour 1989). The mean age of wood turtles recorded in the wild is 20 and 21 years, for females and males, respectively (Harding and Bloomer 1979), but individuals can attain ages of 40–58 years (Oliver 1955). Both sexes attain sexual maturity at around 11–19 years (Greaves and Litzgus 2009). Wood turtles usually lay one clutch per year, and a clutch may contain 3 – 20 eggs, but the average clutch size is 8– 11 eggs (Harding and Bloomer 1979; Farrell and Graham 1991; Ross et al. 1991; Brooks et al. 1992; Akre 2002; Greaves and Litzgus 2009). Approximately 68% of females are gravid in any given year (Walde et al. 2007). Little is known about hatchling sex-ratios, but wood turtles exhibit genetic sex determination (Ewert et al. 2004; Ewert and Nelson 1991). Nest success has been reported to range from 65 to 75% (Walde et al. 2007) but no studies have examined survival in younger turtles, notably from hatching to age 1. Juvenile and adult survival rates have been reported of 82–83% and 87–97%, respectively (Saumure et al. 2007; Schneider et al. 2018).

C.2.2 Trade Data and Captive Breeding

The wood turtle is popular in the pet trade and has suffered from overharvesting throughout its range (Ernst and Lovich 2009). The wood turtle is a high-demand species and commands some of the highest prices among the 12 priority species. Wood turtles are listed as Threatened in Canada (COSEWIC 2007) and have varying protections in every state they are found in the United States (Nanjappa and Conrad 2011), but have no protection at the federal level.

CITES Data Summary:

Between 2000 and 2016, 11 live *G. insculpta* were exported from Canada.
Between 2000 and 2016, 316 live *G. insculpta* were exported from the United States.
Between 2000 and 2016, 226 "specimens" of *G. insculpta* were exported from the United States.

LEMIS Data Summary:

Between 2000 and 2016, the United States imported: 1 GM (grams), 68 (number, live).
Between 2000 and 2016, the United States exported: 497 (number, live).

C.2.3 Data Gaps and Needs

Genetic identification of captive breeding stock, as well as individuals confiscated in illegal trade, would help to identify geographic origin and thus allow offspring to potentially be repatriated to the areas their parents originated from, thus providing conservation benefit.

C.3 Spotted Turtle (*Emydidae: Clemmys guttata*, Schneider, 1792)

C.3.1 Biological Information

The range of the spotted turtle encompasses portions of Canada and the United States: Maine, and west through Quebec, Ontario, New York, Pennsylvania, Ohio, Michigan, Illinois, Indiana, then southward along the Atlantic coast to northern Florida (Ernst and Barbour 1989). Spotted turtles can attain sexual maturity at 7–15 years of age in females and 7–13 in males (Ernst 1970a; Ernst and Zug 1994; Litzgus and Brooks 1998a; Litzgus 2006). Although the species has the estimated potential of extreme longevity—110 years for females and 70 for males (Litzgus 2006)—those estimates are based on tenuous assumptions, and most wild turtles of known age are between 28 and 38 years (Haxton 1998; Seburn 2003; Ernst and Lovich 2009; Feng 2018). Turtles lay eggs in one to two clutches of 1–4 eggs, with most clutches averaging 1–5 eggs (Ernst 1970b; Litzgus and Brooks 1998b; Litzgus and Mousseau 2006; Feng 2018). Clutch size in Illinois populations was found to increase slightly with the age of females (Feng 2018). The overall proportion of females reproducing ranges from 52 to 68% but can vary with adult age (Litzgus and Brooks 1998b; Feng 2018). Nothing is known about hatchling sex ratios but the species exhibits temperature-dependent sex determination (TSD), with lower egg incubation temperatures producing males and higher temperatures producing females (Ewert and Nelson 1991; Ewert et al. 2004). Egg survival rates of 54% in Canada were reported (Enneson and Litzgus 2008). Hatchling survival to age 1 has been estimated at 21–47%, and juvenile survival (ages 2–6) in Illinois varied between 40 and 83% (Feng 2018). Juvenile survival estimated for a population in Canada was 82% (Enneson and Litzgus 2008). Adult female survival (ages 7+) in Illinois ranged from 52 to 99% (Feng 2018). Other studies have found adult survival rates to be 96% for females and 84% for males (Litzgus 2006).

C.3.2 Trade Data and Captive Breeding

Spotted turtles are listed as Endangered in Canada (<http://wildlifepreservation.ca/spotted-turtle/>), with fewer than 2000 individuals believed to exist in Ontario and with the species believed extirpated in Quebec. Spotted turtles have varying levels of protected status in most states in which they are found in the United States (Nanjappa and Conrad 2011), but have no protection at the federal level.

CITES Data Summary:

Between 2000 and 2016, 12 live *C. guttata* were exported from Canada.
Between 2000 and 2016, 349 live *C. guttata* were exported from United States.

LEMIS Data Summary:

Between 2000 and 2016, the United States imported: 84 (number, live).
Between 2000 and 2016, the United States exported: 12,602 (number, live).

During 2000–2016, the United States recorded imports of spotted turtles (84) that exceeded the number exported from Canada (12) during the same time period; therefore the species is presumably being bred outside its native range. Spotted turtles declared as captive-bred are frequently exported from the United States. Confiscated illegal shipments of adult, presumably wild-caught individuals are frequent.

C.3.3 Data Gaps and Needs

Genetic identification of captive-breeding stock, as well as individuals confiscated in illegal trade, would help to identify geographic origins and thus allow offspring to potentially be re-introduced to the areas their parents originated from, thus providing conservation benefits. Several US states are conducting range-wide surveys within the range of the spotted turtle to identify population status.

Regulatory coordination among state and provincial wildlife agencies within the range of the spotted turtle would help to identify weaknesses in regional enforcement and identify where comprehensive regulations could be designed. Efforts are being made to coordinate regulations among different states in the United States (Nanjappa and Conrad 2011).

C.4 Blanding's Turtle (*Emydidae: Emydoidea blandingii*, Holbrook, 1838)

C.4.1 Biological Information

The distribution range of the Blanding's turtle includes portions of eastern Canada and the eastern and midwestern United States. Specifically, the core range extends from western Nebraska through Iowa, Wisconsin, Minnesota and northeastern Missouri, the Great Lakes Region, and Ontario, with isolated populations occurring in Maine, Massachusetts, New York, New Hampshire, and Nova Scotia (Ernst and Barbour 1989). Females in Michigan mature between 14 and 20 years (Ross 1989; Congdon and van Loben Sels 1993; Standing et al. 2000). Blanding's turtles have extreme longevity, and individuals have been found to be as old as 50 to 78 years (Breck and Moriarty 1989; Herman et al. 1995; Congdon et al. 2003). Blanding's turtles usually lay one clutch, on average containing 8 to 15 eggs (Graham and Doyle 1979; MacCulloch and Weller 1988; Rowe 1992; Congdon and van Loben Sels 1993; Pappas et al. 2000; Standing et al. 2000; Joyal et al. 2005). Long-term studies in Michigan show that on average 48% of the females laid eggs annually (Congdon et al. 1983). Blanding's turtles exhibit temperature-dependent sex determination (TSD), whereby males are produced at lower temperatures during incubation and females at higher temperatures (Ewert and Nelson 1991; Gutzke and Packard 1987). Annual nest survival ranged from 0 to 63% among years and averaged 22% over a 25-year study (Congdon et al., 2000). Survivorship for turtles from hatching to age 1 has been reported at 26%, and juvenile survival from 72 to 78% (Congdon et al. 1993; Congdon et al. 2000). Finally, studies in Michigan report adult female survival of 96–98% (Congdon et al. 1993; Congdon et al. 2000) and a shorter-term study in Illinois reported adult survival rates of 93–100% (Rubin et al. 2004).

C.4.2 Trade Data and Captive Breeding

Blanding's turtles are listed as Threatened in Ontario (<www.ontario.ca/speciesatrisk/>) and Endangered in the Nova Scotia portion of their range in Canada (CEC 2017). Blanding's turtles have varying levels of protected status in most states in which they are found in the United States (Endangered: Illinois, Indiana, Maine, Missouri, New Hampshire; Threatened: Iowa, Massachusetts, Minnesota, New York, Ohio) (Nanjappa and Conrad 2011), but have no protection at the federal level.

Malaclemys terrapin (Diamondback terrapin), recovering road injury, Kurt A. Buhlmann

Emydoidea blandingii (Blandings Turtle), Kurt A. Buhlmann

CITES Data Summary:

Between 2000 and 2016, 809 live *E. blandingii* were exported from the United States.
Between 2000 and 2016, 48 "specimens" of *E. blandingii* were exported from the United States.

LEMIS Data Summary:

Between 2000 and 2016, the United States imported: 4 (number, live).
Between 2000 and 2016, the United States exported: 2,571 (number, live).

Captive breeding is presumably occurring for commercial trade, although further information is lacking. A captive-breeding database of permitted breeders would be helpful. Participants at this workshop have heard of nests being poached on protected areas in northeast United States. Head-starting projects for Blanding's turtles, with the goal of producing juveniles with higher survivorships, have been initiated; these projects also help with public awareness (Buhlmann et al. 2015).

C.4.3 Data Gaps and Needs

Blanding's turtle represents one of the best-studied freshwater turtle species, in regard to knowledge of life history. Life-history information on this species is provided by Congdon et al. (1983, 1993) and Congdon and van Loben Sels (1993).

C.5 Diamond-backed Terrapin (*Emydidae: Malaclemys terrapin*, Schoepff, 1793)

C.5.1 Biological Information

The diamond-backed terrapin is found along the Atlantic and Gulf Coasts of the United States. The distribution extends from Cape Cod, Massachusetts, south throughout the Florida Keys, and west to Texas (Ernst and Barbour 1989). Females have been found to mature at 6–13 years old and males at 3–7 (Cagle 1952; Montevecchi and Burger 1975; Lovich and Gibbons 1990; Roosenburg 1992). Longevity in the wild is not well understood, but diamond-backed terrapins may live anywhere between 14 and 40 years in captivity (Hildebrand 1932; Seigel 1984; Snider and Bowler 1992). Terrapins lay 2–3 clutches annually, and each cluth may contain 6–15 eggs (Montevecchi and Burger 1975; Roosenberg and Dunham 1997; Segiel 1980; Goodwin 1994; Roosenburg and Dunham 1997; Feinberg and Burke 2003; Roosenberg and Dennis 2005). Diamond-backed terrapins exhibit temperature-dependent sex determination (TSD), whereby lower temperatures during nest development produce males, and higher temperatures produce females (Sachase 1984; Ewert and Nelson 1991; Jeyasuria et al. 1994; Roosenburg and Kelly 1996). Nest survival rates are highly variable, ranging from 1 to 84% (Burger 1977; Iverson 1991; Roosenberg 1992; Feinberg 2003, 2004; Butler et al. 2004). Diamond-backed terrapins are extremely susceptible to crab traps, and populations often suffer very high mortality rates. In populations where crab traps are set, mortality rates run as high as 58–78% (Roosenberg et al. 1997). Little work to generate baseline population estimates has been conducted on survival rates of hatchlings, juveniles, and adults in unaffected systems.

C.5.2 Trade Data and Captive Breeding

Diamondback terrapins have no federal protection in the United States, but are listed threatened in Massachusetts (Nanjappa and Conrad 2011).

CITES Data Summary:

Between 2000 and 2016, 10 live *M. terrapin* were exported from Canada.
Between 2000 and 2016, 27,811 live *M. terrapin* were exported from United States.

LEMIS Data Summary:

Between 2000 and 2016, the United States imported: 144,001 (number, live) as *Malaclemys* spp. and 86 NO (number, live) as *Malaclemys terrapin*.
Between 2000 and 2016, the United States exported: 5,222 (number, live) as *Malaclemys* spp. and 61,314 (number, live) as *Malaclemys terrapin*.

Diamondback terrapin hatchlings have been produced in large numbers at a "farming" operation in Maryland. However, in one particular year more hatchlings were delivered in shipments than it seemed that the female breeding stock could produce. It was found that, in the year after this farm was inspected, additional adult breeding stock had been obtained by dredging up hibernating adult turtles in a New Jersey salt marsh. Thus, there were many more hatchlings exported than could have been accounted for by the previously inspected number of known females on the farm. That "farm" is better defined as a "ranch," since adult breeding stock is being added from the wild to produce more hatchlings for trade.

C.5.3 Data Gaps and Needs

Studies to determine if hatchling diamondback terrapins might be harvested from protected nests in the wild are necessary. A pilot project concept was outlined during the workshop.

C.6 Eastern Box Turtles (*Emydidae: Terrapene carolina*, Linnaeus, 1758)

C.6.1 Biological Information

The Eastern box turtle has a large distribution range across the United States and including parts of Canada and Mexico. The distribution extends from southern Maine to northern Florida and west to Missouri, southern Kansas, Oklahoma, and Texas (Enrst and Barbour 1989). Two isolated subspecies populations are found in central Mexico. The Mexican box turtle, *T.c. mexicana*, occurs in the states of San Luis Potosí, Tamaulipas, and Veracruz (Keister and Wiley 2015). The Yucatán box turtle, *T.c. yucatana* (Ernst and Barbour 1989; Keister and Willey 2015) are found in the Yucatán Peninsula states of Campeche, Quintana Roo, and Yucatán. Eastern box turtles are known for their longevity and have been recorded up to 138 years old (Oliver 1955), but generally live between 50 and 80 years (Stickel 1978; Williams and Parker 1987; Dundee and Rossman 1989; Miller 2001; Schwartz 2001), with most wild individuals living between 25 and 35 years (Stickel 1978). Both sexes typically mature between 5 and 10 years of age, with females maturing mostly at 7–8 years and males at 5–6 years (Minton 1972; Dodd 1997). Clutch sizes range from 1 to 11 eggs, but the proportion of females reproductively active in any year remains unknown (Ernst and Lovich 2009; Keister and Willey 2015). The females average 1–3 clutches per year (Ernst and Lovich 2009; Keister and Willey 2015). Eastern box turtles exhibit temperature-dependent sex determination (TSD), whereby females are produced from nest development at above the pivotal temperature of 28°C, and males below (Diamond 1983; Ewert and Nelson 1991; Ewert et al. 2004). Egg and nest success rates vary considerably and can range from 55 to 95% (Messinger and Patton 1995; Burke and Capitano 2011; Willey and Sievert 2012). Nest predation rates range from 0 to 100% (Keister and Willey 2015). There is no information on the survival of first-year individuals in particular, because these individuals are so cryptic. Some of the best survival data come from long-term

studies in Missouri conducted by Schwartz and Schwartz (1974, 1991), who found juvenile survival rates averaged 66.3% (43–91%) and adult survival rates varied from 68 to 100% annually (Schwartz and Schwartz 1974, 1991). Other studies report annual adult survival rates ranging from as low as 56% up to 96% (Verdon and Donnelly 2005; Nazdrowicz et al. 2008; Currylow et al. 2010).

C.6.2 Trade Data and Captive Breeding

Major exporting has occurred in the late 20th century in association with the pet trade (Keister and Willey 2015). Before its CITES Appendix II listing, it was informally estimated that ~25,000–30,000 Eastern and ornate box turtles were exported from the United States annually (Stevens 1994). The number of turtles caught and traded or sold within county borders remains unknown but could be substantial, as they are a popular pet. Also, the two Mexican subspecies (*T.c. mexicana* and *T.c. yucatana*) appear to be showing up in collections and for sale at an alarmingly high rate. With no real large-scale breeders/farms of the species known (outside of China), it is thought many of these individuals are wild caught (particularly those of the Mexican species). As a popular pet, there are innumerable resources for the captive husbandry of the species, but most captive breeding in North America is relegated to hobbyists. Confiscated illegal shipments of adult, presumably wild-caught individuals are becoming more frequent (The Wildlife Professional Nov/Dec 2018). Box turtles are becoming a species of concern in much of the United States, and are listed as Endangered in Maine (Nanjappa and Conrad 2011). Box turtles are listed as Extirpated in Canada (COSEWIC 2014).

CITES Data Summary:

Between 2000 and 2016, 22 live *Terrapene* sp. were exported from Canada.
Between 2000 and 2016, 1 live *Terrapene* sp. was exported from the United States.
Between 2000 and 2016, 193 live *Terrapene* sp. were exported from Mexico.

Between 2000 and 2016, 47 live *T. carolina* were exported from Canada.
Between 2000 and 2017, 206 live *T. carolina* were exported from the United States.
Between 2000 and 2016, 193 live *Terrapene* sp. were exported from Mexico.
Between 2000 and 2017, 10 "specimens" of *T. carolina* were exported from the United States.

LEMIS Data Summary:

Between 2000 and 2016, the United States imported: 166 (number, live) as *Terrapene carolina* and 200 (number, live) as *Terrapene* sp.
Between 2000 and 2016, the United States exported: 394 (number, live) as *Terrapene carolina* and 8 (number, live) as *Terrapene* sp.

C.6.3 Data Gaps and Needs

Although the Eastern box turtle is one of the most ubiquitous turtle species in North America, there are range-wide data gaps in understanding its ecology and life history. In particular, there is a lack of targeted studies examining survival in the first year of life and understanding how many females are reproductive in any given season. Because the species is so broadly distributed, range-wide studies focusing on reproduction, survival, and growth will be necessary. Also, we have little understanding of the two Mexican species and effort should be made to examine all aspects of their ecology to determine the effects of harvest pressure.

Because Eastern box turtles are such popular pets, it will be nearly impossible to estimate the size of the captive population, but efforts can be made to query hobbyist-breeder groups and zoos. Although the species is in decline in the United States, it can still be locally abundant, but proactively establishing a network for future assurance colonies could be beneficial. It will also be important to track the origin and numbers of the two Mexican subspecies as their popularity in the market increases.

C.7 Spotted Box Turtle (*Emydidae: Terrapene nelsoni*, Stejneger, 1925)

C.7.1 Biological Information

The spotted box turtle is distributed in disjunct populations ranging across southern Sonora, Sinaloa, and Nayarit, in Mexico (Ernst and Barbour 1989; Buskirk and Ponce-Campos 2011). There is extremely little known about the life history and ecology of this species. It inhabits savannahs, woodlands, and dry scrub forests at higher elevations (Ernst and Barbour 1989; Buskirk and Ponce-Campos 2011). Females produce clutches which range in size from 1 to 4 eggs, predominantly 3 eggs, and there is only one clutch per year (Milstead and Tinkle 1967).

C.7.2 Trade Data and Captive Breeding

Mexico does not allow trade of this species, and there is a high demand for it in the trade market, especially in China. According to CITES data, there are few legal spotted box turtles exported from Mexico (30–40 specimens), yet there are many observed in the Chinese and Hong Kong markets (P.P. van Dijk, pers comm.; D. Gaillard, pers. comm.). There are breeding farms for the species in China and possibly two known breeders in Mexico. This species is not easily bred in captivity, due to its low reproductive output. Thus, its scarce abundance means that there will always be a demand. Because captive husbandry is challenging, there is currently no captive breeding done under UMAs. Most other captive breeding is likely done by hobbyists.

CITES Data Summary:

Between 2000 and 2017, 82 "specimens" of *Terrapene nelsoni* were exported from Mexico. None was a living individual.

LEMIS Data Summary:

Between 2000 and 2016, the United States imported: 2 (number, live).

C.7.3 Data Gaps and Needs

There are few turtles listed as DD (Data Deficient) on the current IUCN Red List, but the spotted box turtle is one of those (TTWG 2017). The severe lack of data on the ecology and life history of this species is alarming, given the pressure and potential for illegal trade. It is imperative that multiple studies be launched to focus on reproduction, using non-invasive x-radiography techniques to derive firmer information on clutch size, percentage of breeding females, and clutch frequency. Radio telemetry could focus directly on those females to examine nesting, nest survivorship and adult female survivorship. Additionally, enacting a mark/recapture regime will afford additional individuals for radio telemetry survival analyses and an estimation of growth rates, which can then be used to estimate ages of sexual maturity and longevity. Some smaller-scale studies are underway, but more resources need to be directed at obtaining these critical data.

Given the great demand for the species, illegal trade could be high, and therefore confiscations could provide a source for assurance colonies. Additionally, confiscated individuals could be used to determine captive-breeding requirements. Also, incentives need to be enacted to promote sharing of husbandry information and thus better promote successful methods of captive rearing. To maintain good records, it will be necessary for breeders to register and have their breeding stock identified. Then, follow-up visits can be made by law enforcement officials. The species will have a high sustained economic value and therefore must be managed correctly to promote legal trade.

C.8 Ornate Box Turtle (*Emydidae: Terrapene ornata*, Agassiz, 1857)

C.8.1 Biological Information

The ornate box turtle is found in the United States and Mexico. The distribution of the ornate box turtle ranges from as far north as Iowa, Illinois, South Dakota, and eastern Wyoming, to southeastern Arizona, New Mexico, Texas and southwestern Louisiana, in the United States (Ernst and Barbour 1989). In Mexico, the distribution covers the states of Chihuahua and Sonora (Ernst and Barbour 1989). Females are known to mature at 8–11 years and males at 7– 9 years (Legler 1960; Blair 1976; Hammerson 1999). Long-term studies have found that ornate box turtles can achieve longevity of over 26 years, with wild females averaging 23 years and males 22 years (Metcalf and Metcalf 1985), but can live over 42 years in captivity (Ernst and Lovich 2009). These captive turtles lay from 1 to 8 eggs (typically from 4 to 5), in up to two clutches per year (Legler 1960; Doroff and Keith 1990; Nieuwolt-Dacany 1997). The proportion of gravid females in a population annually ranges from 10 to 60% and varies with climate and geography (Doroff and Keith 1990; Nieuwolt-Dacany 1997). Ornate box turtles have temperature-dependent sex determination (TSD), whereby lower temperatures during nest development produce males and higher temperatures produce females (Vogt and Bull 1982). Egg fertility and hatching success range from 42 to 80% (Legler 1960; Doroff and Keith 1990). Although numerous nest predators are identified, there are no data on natural nest-predation rates (Ernst and Lovich 2009). Although little is known about hatchling and juvenile survival rates, some estimates suggest hatchling survival rates of 31%, juveniles of 72%, and adults of 95% (Redder et al. 2006). Reported adult survival rates range from 82 to 99% for females and 81 to 90% for males (Doroff and Keith 1990; Bowen et al. 2004; Converse et al. 2005) and 81 to 96% for both sexes combined (Blair 1976).

C.8.2 Trade Data and Captive Breeding

Ornate box turtles are listed as Endangered in Indiana and Wisconsin, and as Threatened in Illinois and Iowa, in the United States (Nanjappa and Conrad 2011). No known major trade in ornate box turtles appears to be occurring; however, states like Arizona have closed the harvest season for the species (<www.reptilesofaz.org>; C. Jones, pers. comm.) and Illinois prohibits collection of wild turtles without a proper permit. The colorful subspecies *T.o. luteola* (desert ornate box turtle) has a smaller range than *T.o. ornata* and thus may become more sought by collectors. Because of their delayed sexual maturity, the removal of adults from the wild will deplete populations. There are also no known large-scale farms or captive-rearing operations for the species, and captive breeding of both subspecies is likely solely done for conservation purposes or by hobbyists.

CITES Data Summary:

Between 2000 and 2016, 16 live *T. ornata* were exported from Canada.
Between 2000 and 2017, 77 live *T. ornata* were exported from the United States.
Between 2000 and 2016, 10 live *T. ornata* were exported from Mexico.
Between 2000 and 2017, 1 "specimen" of *T ornata* was exported from the United States.
Between 2000 and 2017, 40 "specimens" of *T. ornata* were exported from Mexico.

LEMIS Data Summary:

Between 2000 and 2016, the United States imported: 145 (number, live).
Between 2000 and 2016, the United States exported: 36 (number, live).

C.8.3 Data Gaps and Needs

Although there appears to be solid reproductive information for the species, it has such a wide distribution that clinal studies are necessary to understand its life history and ecology. Much of the work has focused on the eastern subspecies (*T.o. ornata*), but information is severely lacking for the desert subspecies (*T.o. luteola)*. Efforts should be made to obtain vital rates on fecundity and survival across the ranges of both subspecies, particularly in *T.o. luteola*. Hall and Steidel (2003) documented regional declines in Arizona. The efforts for *T.o. luteola* could consist of reproductive, survival, and mark/recapture efforts.

Little is known about the captive population of ornate box turtles in the United States. Because individual states have jurisdiction and the species is protected in many states where it is found, the information on individuals in captive collections may be available. Also, a query could be made across American Zoo and Aquarium Association (AZA)–accredited zoos to determine the zoo population size.

Terrapene ornata ornata (Ornate Box Turtle), Kurt A. Buhlmann

C.9 Mojave Desert Tortoise (*Testudinidae: Gopherus agassizii*, Cooper, 1863)

C.9.1 Biological Information

The Mojave Desert tortoise occupies the geographic extent of the Mojave Desert of the United States and Mexico, which includes southwest Utah to the north, and northern Baja California to the south. Longevity in the Mojave Desert tortoises is not well understood, but some studies report turtles of 67 to 80+ years old (Jennings 1981; Glenn 1983), with wild turtles reaching 32 years of age (Germano 1992). Sexual maturity in females occurs between 15 and 20 years of age (Berry 1978; Mueller et al. 1998), with average ages ranging from 14 to 15 years, depending on geographic location within the Mojave Desert (Germano 1994a). Males in California mature between 16 and 20 years (Miller 1955). Females may lay 1–3 clutches (mostly 2) per season, with 1–8 eggs per clutch (Rostall 1994; Lovich et al. 1999; Wallis et al. 1999; McLuckie and Friedell 2002). Desert tortoises exhibit temperature-dependent sex determination (TSD) (Ernst and Lovich 2009). For eastern Mojave populations, the survival rates were estimated at 51% from hatching to age 1, then 71–89% from age one to maturity (Germano 1994b). Adult survival rates hover around 95% (Luckenbach 1982) but can vary, depending on environmental conditions, and are reported as low as 88% (Turner et al. 1984). Specifically, annual adult survivorship in the eastern Mojave ranges from 75 to 98%, and in the western Mojave Desert from 84 to 100% (Germano 1994b).

C.9.2 Trade Data and Captive Breeding

The Mojave Desert tortoise is federally protected (listed as Threatened) in the United States. No known large-scale captive breeding is occurring for this species. If captive breeding is occurring, it is relegated to direct conservation efforts and hobbyists. Few turtles of the genus *Gopherus* have been observed in the Asian turtle markets (P.P. van Dijk, D. Gaillard, pers.comm).

Note: The Mojave Desert tortoise data below include the Sonoran Desert tortoise (*Gopherus morafkai*), as the latter was only recently recognized as a separate species.

CITES Data Summary:

Between 2000 and 2016, 1 live *G. agassizii* was exported from Canada.
Between 2000 and 2017, 3 live *G. agassizii* were exported from the United States.
Between 2000 and 2016, 77 live *G. agassizii* were exported from Mexico.
Between 2000 and 2017, 700 "specimens" of *G. agassizii* were exported from the United States.
Between 2000 and 2017, 3950 "specimens" of *G. agassizii* were exported from Mexico.

LEMIS Data Summary:

Between 2000 and 2016, the United States imported: 738 (number, live).
Between 2000 and 2016, the United States exported: 703 (number, live).

C.9.3 Data Gaps and Needs

There is much-published research on the Mojave Desert tortoise's life history. However, a range-wide synthesis of data is warranted in order to direct future conservation-related efforts. For example, estimates of survival rates for the species could be bolstered significantly, either through additionally targeted radio-telemetry or through a synthesis of unpublished work. Such data could then begin to produce valuable metrics for examining trends in wild population.

Agencies responsible for Mojave Desert tortoise conservation could provide information on the level of captive-breeding efforts occurring for conservation purposes. Specifically, data on head-starting projects, with follow-up juvenile survivorship rates, are being obtained (Daly et al. in review). Also, the agencies might have information about hobbyist breeding, if permitted. Additionally, a query could be made to AZA-accredited zoos that house the species, to determine if they are breeding the species in captivity. The results from all queries would allow an estimate of captive-population size.

C.10 Sonoran Desert Tortoise (*Testudinidae: Gopherus morafkai*, Murphy, Berry, Edwards, Leviton, Lathrop, and Riedle, 2011)

C.10.1 Biological Information

The Sonoran Desert tortoise is found in the United States and Mexico. The species ranges as far north as southern Nevada, south through Arizona to Sonora in Mexico; the populations in northern Sonora and Sinaloa were split off as Goode's scrub tortoise, *Gopherus evgoodei*, in 2016. The Sonoran Desert tortoise is estimated to live up to 62 and 64 years, for males and females, respectively (Germano et al. 2002), with most individuals in the wild being on average 35 years old (Germano 1992). Female sexual maturity in Arizona populations occurs between 10 and 20 years (Averill-Murray and Klug 1999; Averill-Murray et al. 2002) but averages 15 years in the Sonoran Desert (Germano 1994a). Sonoran Desert tortoise males likely reach sexual maturity similarly to Mojave Desert tortoises, at 16–20 years. In this species, roughly 78% of the females typically lay only one clutch per season, comprising 1–12 eggs (Murray et al. 1996; Averill-Murray et al. 2002). Nothing is currently known about hatchling sex ratios, but the tortoise exhibits temperature-dependent sex determination (TSD) (Ernst and Lovich 2009). Although the species has numerous nest predators, little is known about nest success/survival (Ernst and Lovich 2009), or about hatchling and juvenile survival rates. Adult survival rates vary among Arizona populations, from 94 to 97 % (Averill-Murray et al. 2002), but are often less (77–81%) during periods of drought (Zylstra et al. 2012).

C.10.2 Trade Data and Captive Breeding

The Sonoran Desert tortoise is federally protected (listed as Threatened) in the United States. No major captive-breeding efforts are known for this species, and if any are occurring, they are probably limited to hobbyists.

Note: For data on the Sonoran Desert Tortoise (*Gopherus morafkai*), see the CITES and LEMIS data summaries for the Mojave Desert tortoise (above), in which the Sonoran was included as it was only recently recognized as a separate species.

C.10.3 Data Gaps and Needs

Queries should be made to the state agencies (i.e., in Arizona) responsible for Sonoran Desert tortoise conservation efforts to determine the level of captive breeding occurring for conservation purposes. A query could be made to American Zoo and Aquarium (AZA)–accredited zoos that house the species, to determine if they are breeding the species in captivity. The results from all queries would allow an estimate of captive-population size.

Gopherus berlandieri (Berlandiers Tortoise), Kurt A. Buhlmann

C.11 Berlandier's Tortoise (*Testudinidae: Gopherus berlandieri*, Agassiz, 1857)

C.11.1 Biological Information

The Berlandier's tortoise is found in the Tamaulipan thornscrub ecoregion and ranges in Mexico, from Tamaulipas, north through eastern Coahuila and Nuevo León up into the United States, in southern Texas and north to San Antonio (Ernst and Barbour 1989). The only record of longevity in the Berlandier's tortoise shows 52 years for a captive individual (Judd and McQueen 1982); however, the tortoises appear to be shorter-lived in the wild (Hellgren et al. 2000; Kazmaier et al. 2001). Little is known about the age of sexual maturity in female and male Berlandier's tortoises, but what is known suggests they mature around 13 years (Germano 1994a). Females may lay between 1 and 10 eggs but predominantly 1–4 eggs per year, and clutch sizes average 2 eggs (Stuart 1974; Rose and Judd 1982; Judd and Rose 1989). Females also may lay 1–2 clutches per year, with the proportion of gravid females ranging from 31 to 37% annually (Hellgren et al. 2000). Berlandier's tortoises exhibit temperature-dependent sex determination (TSD), but the pivotal temperature for producing male or female offspring is unknown (Rose and Judd 2014). Adult sex ratios typically are about 1:1 but can vary from female- to male-biased, depending upon the year (Hellgren et al. 2000). Although numerous predators of Berlandier's tortoises have been identified, there are no data on nest predation/survival rates in the primary literature. One study did broadly examine survival and found survivorship was 54% for turtles at ages 1 to 3 and 79% for turtles older than 4 years, with males having greater overall survivorship than females (Hellgren et al. 2000).

C.11.2 Trade Data and Captive Breeding

Berlandier's tortoise is listed as Threatened in Texas (<https://tpwd.texas.gov/>). In the United States, captive-breeding efforts are unknown. In Mexico, it is presumed, but unclear, that there are farms where Berlandier's tortoises are captively bred for sale in the trade.

CITES Data Summary

Between 2000 and 2016, 1 live *G. berlandieri* was exported from Canada.
Between 2000 and 2017, 11 live *G. berlandieri* were exported from the United States.
Between 2000 and 2016, 602 live *G. berlandieri* were exported from Mexico.
Between 2000 and 2016, 3 live *Gopherus* sp. were exported from Mexico.

LEMIS Data Summary:

Between 2000 and 2016, the United States imported: 70 (number, live).
Between 2000 and 2016, the United States exported: 6 (number, live).

C.11.3 Data Gaps and Needs

There are large data gaps in the biology of the Berlandier's tortoise, as most of the data come mainly from the United States. However, the tortoises occupy a large range in Mexico and data are needed. Some fundamental data, such as for nest survival and juvenile survival rates, need to be better understood if conservation efforts are going to be directed toward captive breeding. Range-wide survival and reproductive data could be used to assist in conservation determinations. Several papers suggest that the Berlandier's tortoise may be shorter-lived than its congeners (see Hellgren et al. 2000; Kazmaier et al. 2001).

Some international trade does occur, originating from Mexico, and many of these individuals may be wild-harvested. Understanding of possible farming practices in Mexico for the species is needed. There is an opportunity for a multinational approach between the United States and Mexico.

C.12 Gopher Tortoise (*Testudinidae: Gopherus polyphemus*, Daudin, 1802)

C.12.1 Biological Information

The gopher tortoise has a distribution in the United States from South Carolina south along the Atlantic Coast through Florida, then west along the Gulf Coast to eastern Louisiana (Ernst and Barbour 1989). Maximum longevity of wild gopher tortoises is between 50 and 70 years (Germano 1994b). Sexual maturity in female gopher tortoises varies between 9 and 21 years, with most populations maturing between 10 and 15 years (Iverson 1980; Landers et al. 1980; Diemer 1986; Smith 1992; Mushinsky et al. 1994; Tuma 1996). Males mature between 16 and 20 years (Landers et al. 1980; Tuma 1996). Clutch sizes vary from 4 to 9 eggs, and females lay one clutch per year; approximately 70% of females may be gravid each year (Tuma 1996). Gopher tortoises exhibit temperature-dependent sex determination (TSD), with a pivotal temperature of around 29°C (Burke et al. 1996). Nest survivorship ranges from 11 to 45% (Landers et al. 1990; Marshall 1987). Hatching success of nests ranges between 29 and 82% (Butler and Hull 1996; Epperson and Heise 2003). First-year survivorship ranges from 6 to 8% (Alford 1980; Witz et al. 1992). Annual subadult and adult survival has been calculated at 89% (Layne 1989).

C.12.2 Trade Data and Captive Breeding

Gopher tortoises are federally protected in the United States as Threatened in the western portion of their range (Mississippi and Louisiana), and have varying levels of state protections in the eastern portion of their range (Alabama, Georgia, Florida, South Carolina). Currently, there are no large-scale turtle-farming operations in North America for gopher tortoises. At present, gopher tortoises are rarely seen in international trade (D. Gaillard, pers. comm.; P.P. van Dijk, pers. comm.). Head-starting projects for gopher tortoises have been initiated, with the goal of producing juveniles for population recovery efforts (Quinn et al. 2018).

CITES Data Summary

Between 2000 and 2016, 5 live *G. polyphemus* were exported from the United States.

LEMIS Data Summary:

Between 2000 and 2016, the United States exported: 5 (number, live).

C.12.3 Data Gaps and Needs

Population-level survey efforts are necessary, as minimum viable populations (MVPs) of gopher tortoises would be at least 250 adults in colonies in areas of at least 100 hectares (ha) in size, with tortoise densities of no less than 0.4 tortoises/ha. Few populations are found to be existing at this MVP (Gopher Tortoise Council 2013). Population viability analyses (PVAs) have been modeled and indicate long-term conservation issues for the gopher tortoise (Tuberville et al. 2009).

For trade and captive rearing, it will be important to query the conservation agencies within the range to determine how many individuals are in private collections and zoos. This will provide an estimate of captive-population size and help gauge if sustainable trade could be maintained through captive rearing.

Bibliography

Akre, T.S.B. 2002. Growth maturity, and reproduction of the wood Turtle, *Clemmys insculpta* (LeConte) in Virginia. Upubl. Ph.D. Dissertation, George Mason University, Fairfax Virginia.

Alford, R.A. 1980. Population structure of *Gopherus polyphemus* in northern Florida. *Journal of Herpetology* 14:177–82.

Auliya, M., S. Altherr, D. Ariano-Sanchex, E.H. Baard, C. Brown, R.M. Brown, J.C. Cantu, G. Gentile, P. Gildenhuys, E. Henningheim, et al. 2016. Trade in live reptiles, its impact on wild populations, and the role of the European market. *Biological Conservation* 204:103–119. Available at: <www.sciencedirect.com/science/article/abs/pii/S0006320716301987>.

Averill-Murray, R.C., and C.M. Klug. 1999. Reproduction in desert tortoises in the Sonoran desert, Arizona. *Sonoran Herpetologist* 12:70–72.

Averill-Murray, R.C., A.P. Woodman, and J.M. Howland. 2002. Population ecology of the desert tortoise in Arizona. *In:* T.R. Vandevender (ed.). *The Sonoran desert tortoise: Natural history, biology and conservation*, pp. 109–134. Tucson, Arizona: University of Arizona Press.

Behler, J.L. 1997. Troubled times for turtles. *In*: Van Abbema, J. (ed.). *Proceedings: Conservation, Restoration, and Management of Tortoises and Turtles – An International Conference*. New York: New York Turtle and Tortoise Society.

Berry, K.H. 1978. Livestock grazing and the desert tortoise. *Transactions of the 43rd North American Wildlife Natural Resources Conference*, pp. 505–591.

Blair, W.F. 1976. Some aspects of the biology of the ornate box turtle, *Terrapene ornata*. *Southwestern Naturalist* 21:89–104.

Bowen, K.D., P.L. Colbert, and F.J. Janzen. 2004. Survival and recruitment in a human-impacted population of ornate box turtles, *Terrapene ornata*, with recommendations for conservation and management. *Journal of Herpetology* 38:562–568.

Breck, B., and J.J. Moriarty. 1989. *Emydoidea blandingi* (Blanding's Turtle) longevity. *Herpetological Review* 20:53.

Brooks, R.J., C.M. Shilton, G.P. Brown, and N.W.W Quinn. 1992. Body size, age distribution, and reproduction in a northern population of wood turtles (*Clemmys insculpta*). *Canadian Journal of Zoology* 70:462–469.

Brown, D.J., V.R. Farallo, J.R. Dixon, J.T. Baccus, T.R. Simpson, et al. 2011. Freshwater turtle conservation in Texas: Harvest effects and efficacy of the current management regime. *Journal of Wildlife Management* 75:486–494.

Browne, C.L., and S.J. Hecnar. 2007. Species loss and shifting population structure of freshwater turtles despite habitat protection. *Biological Conservation* 138:421–429.

Buhlmann, K.A., T.S.B. Akre, J.B. Iverson, D. Karapatakis, R.A. Mittermeier, A. Georges, A.G.J. Rhodin, P.P. van Dijk, and J.W. Gibbons. 2009. A global analysis of tortoise and freshwater turtle distributions with identification of priority conservation areas. *Chelonian Conservation and Biology* 8:116–149.

Buhlmann, K.A., S.L. Koch, B.O. Butler, T.D. Tuberville, V.J. Palermo, B.A. Bastarache, and Z.D. Cava. 2015. Reintroduction and head-starting: Tools for Blanding's turtle conservation. *Herpetological Conservation and Biology* 10:436–454.

Buhlmann, K.A., and C.P. Osborn. 2011. Use of an artificial nest mound by wood turtles (*Glyptemys insculpta*): A tool of turtle conservation. *Northeastern Naturalist* 18(3): 315–334.

Buhlmann, K.A., and T.D. Tuberville. 1998. Use of passive integrated transponder (PIT) tags for marking small freshwater turtles. *Chelonian Conservation and Biology* 3:102–104.

Bush, E.R., S.E. Baker, and D.W. MacDonald. 2014. Global trade in exotic pets 2006–2012. *Conservation Biology* 28:663–676.

Burke, R.L., and W. Capitano. 2011. Nesting ecology and hatching success of the Eastern Box Turtle, *Terrapene carolina*, on Long Island, New York. *The American Midland Naturalist* 165:137–142.

Burke, R. L., M.A. Ewert, J.B. McLemore, and D.R. Jackson. 1996. Temperature-dependent sex determination and hatching success in the Gopher Tortoise (*Gopherus polyphemus*). *Chelonian Conservation and Biology* 2:86–88.

Burger, J. 1977. Determinants of hatchling success in Diamondbacked Terrapin, *Malaclemys terrapin*. *American Midland Naturalist* 97:444–464.

Buskirk, J.R., and P. Ponce-Campos. 2011. *Terrapene nelson* Stejjneger 1925 – Spotted Box Turtle, Tortuga de Chospitas, Tortuga de Monte. *In* Rhodin, A. G. J., P. C. H. Pritchard, P. P. van Dijk, R. A. Saumure, K. A. Buhlmann, J. B. Iverson, and R. A. Mittermeier (Eds.). Conservation Biology of Freshwater Turtles and Tortoises: A compilation project of the IUCN/SSC Tortoise and Freshwater Turtle Specialist group. *Chelonian Research Monographs* No. 5:060.1-060.9. <doi:10.3854/rm.5.060.nelsoni.v1.2011, http://www.iucn-tftsg.org/cbftt>.

Butler, J.A., and T.W. Hull. 1996. Reproduction of the tortoise, *Gopherus polyphemus*, in northeastern Florida. *Journal of Herpetology* 30:14–18.

Butler, J. A., C. Broadhurst, M. Green, and Z. Mullin. 2004. Nesting, nest predation, and hatchling emergence in the Carolina Diamondback Terrapin, *Malaclemmys terrapin cnetrata*, in northeastern Florida. *American Midland Naturalist* 152:145–155.

Cagle, F.R. 1939. A system of marking turtles for future identification. *Copeia* 1939(3):170–173.

———. 1952. A Louisiana terrapin population (*Malaclemys*). *Copeia* 1952:74–76.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2007. *COSEWIC assessment and update status report on the Wood turtle (*Glyptemys insculpta*) in Canada*. Ottawa: Committee on the Status of Endangered Wildlife in Canada. Vii + 42 pp.

———. 2014. *COSEWIC assessment and status report on the Eastern Box Turtle (*Terrapene carolina*) in Canada*. Ottawa: Committee on the Status of Endangered Wildlife in Canada. 36 pp.

Commission for Environmental Cooperation (CEC). 2017. *Sustainable Trade in Turtles and Tortoises: Action Plan for North America*. Montreal, Canada: Commission for Environmental Cooperation, 60 pp.

Congdon, J.D., and R.C. van Loben Sels. 1993. Relationships of reproductive traits and body size with attainment of sexual maturity and age in Blanding's Turtles (*Emydoidea blandingii*). *Journal of Evolutionary Biology* 6:547–557.

Congdon, J.D., A.E. Dunham, and R.C. van Loben Sels. 1993. Delayed sexual maturity and demographics of Blanding's Turtles (*Emydoidea blandingii*): Implications for conservation and management of long-lived organisms. *Conservation Biology* 7:826–833.

———. 1994 Demographics of Common Snapping Turtles (*Chelydra serpentine*): Implications for management of long-lived organisms. *American Zoologist* 34:397–408.

Congdon, J.D., R.D. Nagle, and O.M. Kinney. 2018. Front-loading life histories: The enduring influence of juvenile growth on age, size, and reproduction of primiparous female freshwater turtles. *Evolutionary Ecology Research* 19:353–364.

Congdon, J.D., D.W. Tinkle, G.L. Breitenbach, and R.C. van Loben Sels. 1983. Nesting ecology and hatching success in the turtle *Emydoidea blandingi*. *Herpetologica* 39:417–429.

Congdon, J.D., R.D. Nagle, M.E. Osentoski, O.M. Kinney, and R.C. van Loben Sels. 2003. Life history and demographic aspects of aging in the long-lived turtle (*Emydoidea blandingii*). *In*: Finch, C.E., J.-M. Robine, and C. Yves (eds.). *Brain and longevity.* Pp. 15–31. Berlin: Springer.

Congdon, J.D., R.D. Nagle, O.M. Kinney, M. Osentoski, H.W. Avery, R.C. van Loben Sels, and D.W. Tinkle. 2000. Nesting ecology and embryo mortality: Implications for hatching success and demography of Blanding's turtles (*Emydoidea blandingii*). *Chelonian Conservation and Biology* 3:569–579.

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). 1973. Convention on International Trade in Endangered Species of Wild Fauna and Flora. <www.cites.org/eng/disc/text.php#II>.

Converse, S.J., J.B. Iverson, and J.A. Savidge. 2005. Demographics of an Ornate Box Turtle population (*Terrapene ornata ornata*) in the Nebraska Sandhills. *American Midland Naturalist* 148:416–422.

Currylow, A.F., P.A. Zollner, B.J. MacGowan, and R.N. Williams. 2010. A survival estimate of midwestern adult Eastern Box Turtles using radiotelemetry. *The American Midland Naturalist* 165:143–149.

Daly, J.A., K.A. Buhlmann, B.D. Todd, C.T. Moore, J.M. Peaden, and T.D. Tuberville. 2018. Comparing growth and body condition of indoor-reared, outdoor-reared, and direct-released juvenile Mojave Desert Tortoises. *Herpetological Conservation and Biology* 13(3):622–633.

Diario Oficial de la Federación (DOF—Official Federal Gazette). 2000. Ley General de Vida Silvestre, Diario Oficial de la Federación, 3 de julio de 2000, México; disponible en: <www.diputados.gob.mx/LeyesBiblio/ref/lgvs/LGVS_orig_03jul00.pdf>.

———. 2010. Norma Oficial Mexicana NOM-059-SEMARNAT-2010, Protección ambiental—Especies nativas de México de flora y fauna silvestres—Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio; Lista de especies en riesgo, Diario Oficial de la Federación, 30 de diciembre de 2010, México.

———. 2014. Reglamento de la Ley General de Vida Silvestre, Diario Oficial de la Federación, 19 de marzo de 2014, México.

———. 2016. Ley General de Vida Silvestre (última reforma), Diario Oficial de la Federación, 19 de diciembre de 2016, México.

Diemer, J. E. 1986. The ecology and management of the gopher tortoise in southeastern United States. *Herpetologica* 42:125–133.

Dimond, M.T. 1983. Sex of turtle hatchlings as related to incubation temperatures.. *In:* D. Marcellini (ed.). *Proceedings of the 6th reptile Symposium on Captive Propagation and Husbandry National Zoological Park, Washington, D.C. July 28–31, 1982*. Thurmont, Maryland. Pp. 88–101.

Dodd, C.K., Jr. 1997. Population structure and the evolution of sexual size dimorphism and sex ratios in an insular population of Florida Box Turtles (*Terrapene carolina bauri*). *Canadian Journal of Zoology* 75:1495–1507.

Doroff, A.M. and L.B. Keith. 1990. Demography and ecology of an ornate box turtle (*Terrapene ornata*) population in south-central Wisconsin. *Copeia* 1990:387–399.

Dundee, H.A., and D.A. Rossman. 1989. *The amphibians and reptiles of Louisiana*. Baton Rouge, Louisiana: Louisiana State University Press.

Enneson, J.J., and J.D. Litzgus. 2008. Using long-term data and a stage-classified matrix to assess conservation strategies for an endangered turtle (*Clemmys guttata*). *Biological Conservation* 141:1560–1568.

Environment and Climate Change Canada. 2016. Recovery Strategy for the Blanding's Turtle (*Emydoidea blandingii*), Great Lakes / St. Lawrence population, in Canada [Proposed]. Species at Risk Act Recovery Strategy Series. Ottawa: Environment Canada. vii + 49 pp.

Epperson, D.M., and C.D. Heise, 2003. Nesting and hatchling ecology of Gopher tortoises (*Gopherus polyphemus*) in southern Mississippi. *Journal of Herpetology* 37:315–324.

Ernst, C.H. 1970a. Home range of the Spotted Turtle, *Clemmys guttata* (Schneider). *Copeia* 1970:391–393.

———. 1970b. Reproduction in *Clemmy guttata*. *Herpetologica* 26:228–232.

Ernst, C.H., and R.W. Barbour. 1989. *Turtles of the world*. Washington, D.C.: Smithsonian Institution Press.

Ernst, C.H., and J.E. Lovich, 2009. *Turtles of the United States and Canada*, 2nd Edition. Baltimore, Maryland: The Johns Hopkins University Press.

Ernst, C.H., and Zug, G.R.; 1994. Observations on the reproductive biology of the Spotted Turtle, *Clemmys guttata*, in southeastern Pennsylvania. *Journal of Herpetology* 28:99–102.

Ewert, M.A., and E.C. Nelson. 1991. Sex determination in turtles: Diverse patterns and some possible adaptive values. *Copeia* 1991:50–69.

Ewert, M.A., C.R. Etchberger, and C.E. Nelson. 2004. Turtle sex-determining modes and TSD patterns, and some TSD pattern correlates. *In:* Valenzueela, N., and V.A. Lance (eds.). Temperature-dependent sex determination in vertebrates. Washington, DC: Smithsonian Institution Press. Pp. 21–32.

Farrell, R.F., and T.E. Graham. 1991. Ecological notes on the turtle *Clemmys insculpta* in northwestern New Jersey. *Journal of Herpetology* 25:1–9.

Feinberg, J.A. 2003[2004]. Nest predation and ecology of terrapins, *Malaclemys terrapin terrapin*, at Jamaica Bay Wildlife Refuge. *In*: Swarth, C.W., W.M. Roosenberg, and E. Kiviat (eds.). *Conservation and ecology of turtles of the Mid-Atlantic Region: A symposium*. Salt Lake City, Utah: Bibliomania. Pp. 5–12. Paper (2000) available at: <www.academia.edu/33561950/Nest_Predation_and_Ecology_of_Terrapins_Malaclemys_terrapin_terrapin_at_the_Jamaica_Bay_Wildlife_Refuge>.

Feinberg, J.A., and R.L. Burke. 2003. Nesting ecology and predation of Diamondback Terrapins, *Malaclemys terrapin*, at Gateway National Recreation Area, New York. *Journal of Herpetology* 37:517–526.

Feng, C.Y. 2018. Demography of the Spotted Turtle (*Clemmys guttata*) in Illinois. Unpublished M.Sc. Thesis, University of Illinois Urbana-Champaign, Champaign, Illinois.

Germano, D.J. 1992. Longevity and age-size relationships of populations of desert tortoises. *Copeia* 1992:367–374.

———. 1994a. Growth and age at maturity of North American tortoises in relation to regional climate. *Canadian Journal of Zoology* 72:918–931.

———. 1994b. Comparative life histories of North American tortoises. *In*: Bury, R.B., and D.J. Germano (eds.). *Biology of North American tortoises*. United States Department of the Interior National Biological Survey, Fish and Wildlife Research. No. 13. Washington, DC.

Germano, D.J., F.H. Pough, D.J. Morafka, E.M. Smith, and M.J. Demlong. 2002. Growth of desert tortoises. *In*: T.R. Van Devender (ed.). The Sonoran Desert tortoise: Natural history, biology and conservation. Tucson, Arizona: University of Arizona Press. Pp. 265–288.

Gibbons, J.W., D.E. Scott, T.J. Ryan, K.A. Buhlmann, T.D. Tuberville, B.S. Metts, J.L. Greene, T. Mills, Y. Leiden, S. Poppy, and C.T. Winne. 2000. The global decline of reptiles, déjà vu amphibians. *BioScience* 50:653–666.

Glenn, J.L. 1983. A note on the longevity of a captive Desert Tortoise (*Gopherus agassizii*). *In*: *Proceedings of the Eighth Annual Symposium of the Desert Tortoise Council*. Lake Havasu City, Arizona. Pp. 131–132.

Goodwin, C.C. 1994. Aspects of the nesting ecology of the Diamondback Terrapin (*Malaclemys terrapin*) in Rhode Island. Unpublished M.Sc. Thesis, University of Rhode Island, Providence, Rhode Island.

Gopher Tortoise Council (GTC). 2013. *Gopher Tortoise minimum viable population and minimum reserve size*. Working Group Report. Gopher Tortoise Council. 7 pp.

Graeter, G.J., K.A. Buhlmann, L.R. Wilkinson, and J.W. Gibbons (eds). 2013. *Inventory and monitoring: Recommended techniques for reptiles and amphibians*. Partners in Amphibian and Reptile Conservation [PARC] Technical Publication IM-1, Birmingham, Alabama. 321 p.p.

Graham, T.E., and T.S. Doyle. 1979. Dimorphism, courtship, eggs, and hatchlings of the Blanding's Turtle, *Emydoidea blandingii* (*Reptilia, Testudines, Emydidae*) in Massachusetts. *Journal of Herpetology* 13:125–127.

Greaves, W.F., and J.D. Litzgus. 2009. Variation in life-history characteristics among populations of North American wood turtles: A view from the north. *Journal of Zoology* 279:298–309.

Gutzke, W.H.N., and G.C. Packard. 1987. The influence of temperature on eggs and hatchlings of Blanding's Turtles, *Emydoidea blandingii*. Journal of Herpetology 21:161–163.

Hammerson, G.A. 1999. *Amphibians and reptiles in Colorado*. Boulder, Colorado: University Press of Colorado.

Hall, D.H., and R.J. Steidel. 2003. *Ecology and conservation of desert box turtles* (Terrapene ornate luteola) *in Arizona*. Report submitted to Arizona Game and Fish Department, Phoenix, Arizona.

Harding, J.H., and T.J. Bloomer. 1979. The wood turtle, *Clemmys insculpta*. A natural history. *Bulletin of the New York Herpetological Society* 15:9–26.

Haxton, T. 1998. Large Spotted Turtles, *Clemmys gutatta*, sampled in central Ontario. *Canadian Field-Naturalist* 112:717–718.

Hellgren, E.C., R.T. Kazmaier, D.C. Ruthven III, and D.R. Synatzske. 2000. Variation in tortoise life history: Demography of *Gopherus berlandieri*. *Ecology* 81:1297–1310.

Heppell, S.S. 1998. Application of life-history theory and population model analysis to turtle conservation. *Copeia* 1998:367–375.

Herman, T.B., T.D. Power, and B.R Eaton. 1995. Status of Blanding's turtles, *Emydoidea blandingii*, in Nova Scotia, Canada. *Canadian Field-Naturalist* 109:182–191.

Hildebrand, S.F. 1932. Growth of Diamond-back terrapins: Size attained sex ratio and longevity. *Zoologica* (New York) 9:551–563.

Horne, B.D., C.M. Poole, and A.D. Walde. 2012. *Conservation of Asian tortoises and freshwater turtles: Setting priorities for the next ten years. Recommendations and Conclusions from the Workshop in Singapore.* Singapore Zoo and Wildlife Conservation Society.

International Union for the Conservation of Natute (IUCN). 2018. Global policy – About. At: <www.iucn.org/theme/global-policy/about>.

Iverson, J.B. 1980. The reproductive biology of *Gopherus polyphemus* (*Chelonia: Testudinidae*). *American Midland Naturalist* 103:353–359.

Iverson, J.B. 1991. Patterns of survivorship in turtles (order *Testudines*). *Canadian Journal of Zoology* 68:230–233.

Jennings, M.R. 1981. *Gopherus agassizi* (Desert Tortoise): Longevity. *Herpetological Review* 12:81–82.

Jeyasuria P.W., W.M. Roosenberg, and A.R. Place. 1994. Role of P-450 aromatase in sex determination of the Diamondback Terrapin, *Malaclemys terrapin*. *Journal of Experimental Zoology* 270:95–111.

Jones, M.T., H.P. Roberts, and L.L. Wiley. 2018. *Conservation Plan for the Wood Turtle in the Northeastern United States*. Report to the Massachusetts Division of Fisheries and Wildlife and the US Fish and Wildlife Service. 259 pp.

Joyal, L.A., M. McCollough, and M.L. Hunter, Jr. 2000. Populations structure and reproductive ecology of Blanding's Turtle (*Emydoidea blandingii*) in Maine, near the northeastern edge of its range. *Chelonian Conservation and Biology* 3:580–588.

Judd, F.W., and J.C. McQueen. 1982. Notes on the longevity of *Gopherus berlandieri* (*Testudines*). *Southwestern Naturalist* 27:230–232.

Judd, F.W., and F.L. Rose. 1989. Egg production by the Texas tortoise, *Gopherus berlandieri*, in southern Texas. *Copeia* 989:588–596.

Kazmaier, R.T., E.C. Hellgren, D.R. Synatzske, and J.C. Rutledge. 2001. Mark-recapture analysis of population parameters in a Texas Tortoise (*Gopherus berlandieri*) population in southern Texas. *Journal of Herpetology* 35:410–417.

Kiester, A.R. and L.L. Willey. 2015. *Terrapene carolina* (Linnaeus 1758) – Eastern Box Turtle, Common Box Turtle. *In:* Rhodin, A.G.J., P.C.H. Pritchard, P.P. van Dijk, R.A. Saumure, K.A. Buhlmann, J.B. Iverson, and R.A. Mittermeier (eds.). Conservation biology of freshwater turtles and tortoises: A compilation project of the IUCN/SSC Tortoise and Freshwater Turtle Specialist Group. *Chelonian Research Monographs* 5(8):085.1–25. doi:10.3854/ crm.5.085.carolina.v1.2015, <www.iucn-tftsg.org/cbftt/>.

Klemens, M.W., and J.B. Thorbjarnarson. 1995. Reptiles as a food resource. *Biodiversity Conservation* 4:281–298.

Landers, J.L., J.A. Garner, and W.A. McRae. 1980. Reproduction of Gopher Tortoises (*Gopherus polyphemus*) in southwestern Georgia. *Herpetologica* 36:353–361.

Layne, J. N. 1989. Comparison of survival rates and movements of relocated and resident Gopher Tortoises in a south-central Florida population. *Florida Game and Freshwater Fish Commission, Technical Report* 5:73–79.

Legler, J.M. 1960. Natural history of the ornate box turtle, *Terrapene ornata ornata* Agassiz. *University of Kansas Publication of the Museum of Natural History* 11:527–669.

Linder, M.J., and R. Kaplan. 1952. *Translation of Mexican Game Law*. Internet Center for Wildlife Damage Management. Lincoln, Nebraska: University of Nebraska–Lincoln. Available at: <http://digitalcommons.unl.edu/icwdmother/70>.

Litzgus, J.D. 2006. Sex differences in longevity in the Spotted Turtle (*Clemmys guttata*). *Copeia* 2006:281–288.

Litzgus, J.D., and R.D. Brooks. 1998a. Growth in a cold environment: Body size and sexual maturity in a northern population of Spotted Turtles, *Clemmys guttata*. *Canadian Journal of Zoology* 76:773–782.

———. 1998b. Reproduction in a northern population of *Clemmys guttata*. *Journal of Herpetology* 32:252–259.

Litzgus, J.D., and T.A. Mousseau. 2006. Geographic variation in reproduction in a freshwater turtle (*Clemmys guttata*). *Herpetologica* 62:132–140.

Lovich, J.E., and J.W. Gibbons. 1990. Age at maturity influences adult sex ratio in the turtle *Malaclemys terrapin*. *Oikos* 59:126–134.

Lovich, J.E., P. Medica, H. Avery, K. Meyer, G. Bowser, and A. Brown. 1999. Studies of reproductive output of the Desert Tortoise at Joshua Tree National Park, the Mojave National Preserve, and comparative sites. *Park Science* 19:22–24.

Lovich, J.E., J.R. Ennen, M. Agha, and J.W. Gibbons. 2018. Where have all the turtles gone, and why does it matter? *BioScience* 68(10):771–781. doi:10.1093/biosci/biy09.

Luckenbach, R.A.1982. Ecology and management of the Desert Tortoise (*Gopherus agassizii*) in California. *In*: Bury, R.B. (ed.). *North American tortoises: Conservation and ecology*. United States Fish and Wildlife Service Research Report 12. Pp. 1–37.

Luiselli, L., A. Starita, G.M. Carpaneto, G.H. Segniagbeto, and G. Amori. 2016. A short review of the international trade of wild tortoises and freshwater turtles across the world and throughout two decades. *Chelonian Conservation and Biology* 15:167–172.

MacCulloch, R.D., and W.F. Weller. 1988. Some aspects of reproduction in a Lake Erie population of Blanding's Turtle, *Emydoidea blandingii*. *Canadian Journal of Zoology* 66:2317–2319.

Mali, I., M.W. Vandewege, S.K., Davis, and M.R.J. Forstner. 2014. Magnitude of the freshwater turtle exports from the US: Long-term trends and early effects of newly implemented harvest management regimes. *Plos One* 9:e86478.

Marshall, J.E. 1987. The effects of nest predation on hatching success in Gopher Tortoises (*Gopherus polyphemus*) (Daudin, 1802). Unpublished M.Sc. Thesis. University of South Alabama, Mobile.

McLuckie, A.M., and R.A. Fridell. 2002. Reproduction in a Desert Tortoise (*Gopherus agassizii*) population on the Beaver Dam Slope, Washington County, Utah. *Chelonian Conservation and Biology* 4:88–94.

Messinger, M.A., and Patton, G.M. 1995. Five-year study of nesting of captive *Terrapene carolina triunguis*. *Herpetological Review* 26:193–195.

Metcalf, A.L., and E. Metcalf. 1985. Longevity in some Ornate Box Turtles (*Terrapene ornata*). *Journal of Herpetology* 19:157–158.

Miller, J.K. 2001. Escaping senescence: Demographic data from the Three-toed Box Turtle (*Terrapene carolina triunguis*). *Experimental Gerontology* 36:829–832.

Miller, L. 1955. Further observations on the Desert Tortoise, *Gopherus agassizi* of California. *Copeia* 1955:113–118.

Milstead, W. W. & Tinkle, D. W. (1967). Terrapene of western Mexico, with comments on the species groups in the genus. Copeia 1967, 180-187Milstead, W. W., and D. W. Tinkle. 1967. *Terrapene* of western Mexico, with comments on the species groups in the genus. Copeia 1967:180–187

Minton, S.A., Jr. 1972. Amphibians and reptiles of Indiana. *Indiana Academy of Sciences Monographs* 3:1–346.

Montevecchi, W.A., and J. Burger. 1975. Aspects of the reproductive biology of the Northern Diamondback Terrapin, *Malaclemys terrapin terrapin*. *American Midland Naturalist* 94:166–178.

Mueller, J.M., K.R. Sharp, K.K. Zander, D.L. Rakestraw, K.R. Rautenstrauch, and P.E. Lederle. 1998. Size-specific fecundity of the desert tortoise (*Gopherus agassizii*). *Journal of Herpetology* 32:313–319.

Murray, R.C., C.R. Schwalbe, S.J. Bailey, S.P. Cuneo, and S.D. Hart. 1996. Reproduction in a population of the Desert Tortoise, *Gopherus agassizii*, in the Sonoran Desert. *Herpetological Natural History* 4:83–88.

Mushinsky, H.R., D.S. Wilson, and E.D. McCoy. 1994. Growth and sexual dimorphism of *Gopherus polyphemus* in central Florida. *Herpetologica* 50:119–128.

Nanjappa, P., and P.M. Conrad (eds). 2011. *State of the Union: Legal authority over the use of native amphibians and reptiles in the United States*. Version 1.03. Association of Fish and Wildlife Agencies. Washington, D.C. USA.

Glyptemys insculpta (Wood Turtle juvenile), Kurt A. Buhlmann

Nazdrowicz, N.H., J.L. Bowman, and R.R. Roth. 2008. Population ecology of the Eastern Box Turtle in a fragmented landscape. *Journal of Wildlife Management* 72:745–753.

Nieuwolt-Dacanay, P.M. 1997. Reproduction in the western box turtle, *Terrapene ornata luteola*. *Copeia* 1997:819–826.

Oliver, J. A. 1955. *The natural history of North American amphibians and reptiles*. Princeton, New Jersey: D. Van Nostrand.

Organ, J.F., V. Geist, S.P. Mahoney, S. Williams, P.R. Krausman, G.R. Batcheller, T.A. Decker, R. Carmichael, P. Nanjappa, R. Regan, R.A. Medellin, R. Cantu, R.E. McCabe, S. Craven, G.M. Vecellio, and D.J. Decker. 2012. *The North American Model of Wildlife Conservation*. The Wildlife Society Technical Review 12-04. Bethesda, Maryland: The Wildlife Society. Available at: <http://wildlife.org/wp-content/uploads/2014/05/NA-model-summary.pdf>.

Pappas, M.J., B.J. Brecke, and J.D. Congdon. 2000. The Blanding's Turtles (*Emydoidea blandingii*) of Weaver Dunes, Minnesota. *Chelonian Conservation and Biology* 3:557–568.

Quinn, D.P., K.A. Buhlmann, J.B. Jensen, T.M. Norton, and T.D. Tuberville. 2018. Post-release movement and survivorship of head-started gopher tortoises. *The Journal of Wildlife Management*: 82:1545–1554.

Reed, R.N., and J.W. Gibbons. 2003. *Conservation status of the live U.S. non-marine turtles in domestic and international trade*. Report. US Fish and Wildlife Service, Dept. of the Interior. 92 pp.

Redder, A.J., C.K. Dodd, Jr., and D. Keinath. 2006. *Ornate Box Turtle (*Terrapene ornata ornata*): A technical conservation assessment*. USDA Forest Service, Rocky Mountain Region. Available at: <www.fs.fed.us/r2/projects/scp/assessments/ornateboxturtle.pdf>.

Roosenburg, W. M. 1992. The Diamondback Terrapin; Population dynamics, habitat requirements, and opportunities for conservation.. *In*: A. Cheny and J. Mihursky (eds.). *Proceedings of a Conference: New perspective in the Chesapeake System: A research and management partnership*. Chesapeake Research Consortium Publication. 137. Pp. 227–234.

Roosenberg, W.M., and T. Dennis. 2005. Egg component comparisons within and among clutches of the Diamondback Terrapin, *Malaclemys terrapin*. *Copeia* 2005:417–423.

Roosenburg, W.M., and A.E. Dunham. 1997. Allocation of reproductive output: Egg- and clutch-size variation in the Diamondback Terrapin. *Copeia* 1997:290–297.

Roosenburg, W.M., and P.J. Kelly. 1996. The effect of egg size and incubation temperature on growth in the turtle, *Malaclemys terrapin*. *Journal of Herpetology* 30:198–204.

Roosenberg, W.M., M.W. Cresko, M. Modesitte, and M.B. Robbins. 1997. Diamondback Terrapin (*Malaclemys terrapin*) mortality in crab pots. *Conservation Biology* 11:1166–1172.

Rose, F.L., and F.W. Judd. 1982. The biology and status of Berlandier's Tortoise (*Gopherus berlandieri*). *In*: Bury, R.B. (ed.). *North American tortoises: Conservation and ecology*. United States Fish and Wildlife Service Research Report 12. Pp. 57–70.

Ross, D.A. 1989. Population ecology of Painted and Blanding's turtles (*Chrysemys picta* and *Emydoidea blandingii*) in central Wisconsin. *Transactions of the Wisconsin Academy of Sciences Arts and Letters* 77:77–84.

Ross, D.A., K.N. Brewster, R.K. Anderson, N. Ratner, and C.M. Brewster. 1991. Aspects of the ecology of wood turtles, *Clemmys insculpta*, in Wisconsin. *Canadian Field-Naturalist* 105:363–367.

Rostal, D.C., V.A. Lance, J.S. Grumbles, and A.C. Alberts. 1994. Seasonal reproductive cycle of the Desert Tortoise (*Gopherus agassizii*) in the eastern Mojave Desert. *Herpetological Monographs* 8:83–87.

Rowe, J.W. 1992. Observations of body size, growth, and reproduction in Blanding's Turtles (*Emydoidea blandingi*) from western Nebraska. *Canadian Journal of Zoology* 70:1690–1695.

Rubin, C.S., R.E. Warner, D.R. Ludwig, and R. Thiel. 2004. Survival and populations structure of Blanding's Turtles (*Emydoidea blandingii*) in two suburban Chicago forest preserves. *Natural Areas Journal* 24:44–48.

Sachase, W. 1984. Long-term studies of the reproduction of *Malaclemys terrapin centrata*. *In*: Bels, V.K., and A.P. Van der Sande (eds.). *Maintenance and reproduction of reptiles in captivity, Vol 1. Acta Zoologica et Pathologica Antverpensia*. 78. Pp. 297–308.

Saumure, R.A., T.B. Herman, and R.D. Titman. 2007. Effects of haying and agricultural practices on a declining species: The North American Wood Turtle, *Glyptemys insculpta*. *Biological Conservation* 135:565–575.

Schneider, A.C., T.W. Arnold, P.W. Huber, and T.L. Lewis. 2018. An 18-year mark-recapture study of Wood Turtles (*Glyptemys insculpta*) in Michigan. *Journal of Herpetology* 52:193–200.

Schwartz, E.R. 2001. Update on permanent residency, persistence, and longevity in a 35-year study of a population of Three-toed Box Turtles. *Chelonian Conservation and Biology* 3:737–738.

Schwartz, C.W., and E.R. Schwartz. 1974. The Three-Toed Box Turtle in central Missouri: Its population, home range, and movements. *Missouri Department of Conservation Terrestrial Series* 5:1–28.

———. 1991. A quarter-century study of survivorship in a population of Three-Toed Box Turtles in Missouri. *Copeia* 1991:1120–1123.

Seburn, D.C. 2003. Population structure, growth, and age estimation of Spotted Turtles, *Clemmys guttata*, near the northern limit: An 18-year follow-up. *Canadian Field-Naturalist* 117:436–439.

Seigiel, R.A. 1980. Nesting habits of Diamondback Terrapins (*Malaclemys terrapin*) on the Atlantic Coast of Florida. *Transactions of the Kansas Academy of Sciences* 83:239–246.

Seigel, R.A. 1984. Parameters of two populations of Diamondback Terrapins (*Malaclemys terrapin*) on the Atlantic Coast of Florida. *In*: Seigel, R.A., L.E. Hunt, J.L. Knoght, L. Malaret, and N.L. Zuschlag (eds.). *Vertebrate ecology and systematics: A tribute to Henry S. Fitch*. University of Kansas Museum of Natural History Special Publication 10. Pp. 77–87.

Shine, R., and J.B. Iverson. 1995. Patterns of survival, growth, and maturation in turtles. *Oikos* 72:343–348.

Smith, L.L. 1992. Nesting ecology, female home range and activity patterns, and hatchling survivorship in the Gopher Tortoise (*Gopherus polyphemus*). Unpublished M.Sc. Thesis, University of Florida, Gainesville.

Snider, A.T., and J.K. Bowler. 1992. Longevity of reptiles and amphibians in North American collections, 2nd edition. *Society for the Study of Amphibians and Reptiles. Herpetological Circular* 21:1–40.

Spencer, R.J. 2017. Critically evaluating best management practices for preventing freshwater turtle extinctions. *Conservation Biology* (6):1340–1349.

———. 2018. How much long-term data are required to effectively manage a wide-spread freshwater turtle? *Australian Zoologist*. DOI: http://doi.org/ 10.7882/AZ.2018.017.

Standing, K.L., T.B. Herman, and I.P. Morrison. 2000. Predation on neonate Blanding's Turtles (*Emydoidea blandingii*) by short-tailed shrews (*Blarina brevicauda*). *Chelonian Conservation and Biology* 3:658–660.

Stevens, W.K. 1994. Box turtles decline, perishing cruelly in foreign lands. *The New York Times* May 10, 1994:B1, B6.

Stickel, L.F. 1978. Changes in a box turtle population during three decades. *Copeia* 1978:221–225.

Stuart, M. 1974. Reptile breeding data at Louisiana Purchase Gardens and Zoo. *American Associations of Zoological Parks and Aquariums Regular Conference Proceedings* 1974:275–276.

The Wildlife Professional. 2018. Southeast: Four plead guilty to turtle smuggling. 12 (6) Nov/Dec: 14.

Tortoise and Freshwater Turtle Specialist Group (TFTSG). 2018. Global conservation status of turtles and tortoises (Order *Testudines*). *Chelonian Conservation and Biology* 17(2): 135–161.

Tuberville, T.D., J.W. Gibbons, and H.E. Balbach. 2009. *Estimating viability of Gopher Tortoise populations*. Washington, D.C.: US Army Corps of Engineers.

Tuberville, T.D., T.M. Norton, K.A. Buhlmann, and V. Greco. 2015. Head-starting as a management component for Gopher Tortoises (*Gopherus polyphemus*). *Herpetological Conservation and Biology* 10: 455–471.

Tuma, M.W. 1996. Life history and population structure of the Gopher Tortoise (*Gopherus polyphemus*) on Camp Shelby, Mississippi. Year-end report for the 1995 season (April 1995–April 1996). *Mississippi Museum of Natural Sciences Technical Report* 62:1–54.

Turner, F.B., P.A. Medica, and C.I. Lyons. 1984. Reproduction and survival of the Desert Tortoise (*Saptochelys agassizii*) in Ivanpah Valley, California. *Copeia* 1984:811–820.

Turtle Taxonomy Working Group (TTWG) [van Dijk, P.P., J.B. Iverson, A.G.J. Rhodin, H.B. Shaffer, and R. Bour]. 2014. Turtles of the world, 7th edition: Annotated checklist of taxonomy, synonymy, distribution with maps, and conservation status. *Chelonian Research Monographs* 5(7):000.329–479.

Turtle Extinctions Working Group (TEWG) [Rhodin, A.G.J., S. Thomson, G.L. Georgalis, H.-V. Karl, I.G. Danilov, A. Takahashi, M.S. de la Fuente, J.R. Bourque, M. Delfino, R. Bour, J.B. Iverson, H.B. Shaffer, and P.P. van Dijk]. 2015. Turtles and tortoises of the world during the rise and global spread of humanity: First checklist and review of extinct Pleistocene and Holocene chelonians. *Chelonian Research Monographs* 5:000e.1–66.

Van Dijk, P.P., B.L. Stuart, and A.G.J. Rhodin (eds.). 2000. Asian turtle trade: Proceedings of a workshop on conservation and trade of freshwater turtles and tortoises in Asia, Phnom Penh, Cambodia, 1–4 December 1999. *Chelonian Research Monographs* No. 2. Chelonian Research Foundation, Lunenburg, Mass. 164 pp.

Verdon, E., and M.A. Donnelly. 2005. Population structure of Florida Box Turtles (*Terrapene carolina bauri*) at the southernmost limit of their range. *Journal of Herpetology* 39:572–577.

Vogt, R. C., and J.J. Bull. 1982. Genetic sex determination in the Spiny Softshell, *Trionyx spiniferous* (*Testudines: Trionyhidae*). *Copeia* 1982:699–700.

Vogt, R.C., J.R. Polisar, D. Moll, and G. Gonzalez-Porter. 2011. *Dermatemys mawii* Gray 1847 – Central American River Turtle, Tortuga Blanca, Hickatee. *In:* Rhodin, A.G.J., P.C.H. Pritchard, P.P. vanDijk, R.A. Saumure, K.A. Buhlmann, J.B. Iverson, and R.A. Mittermeier (eds.). Conservation biology of freshwater turtles and tortoises: A compilation project of the IUCN/SSC Tortoise and Freshwater Turtle Specialist Group. *Chelonian Research Monographs* 5: 058.1–058.12.

Walde, A.D., J.R. Bider, D. Masse, R.A. Saumure, and R.D. Titman. 2007. Nesting ecology and hatching success of the Wood Turtle, *Glyptemys inscuplta,* in Québec. *Herpetological Conservation and Biology* 2:49-60.

Wallis, I.R., B.T. Henen, and K.A. Nagy. 1999.Egg size and annual egg production by female Desert Tortoises (*Gopherus agassizii*): The importance of food abundance, body size, and date of egg shelling. *Journal of Herpetology* 33:394–408.

Wetlands Institute. 2019. <https://wetlandsinstitute.org/conservation/terrapin-conservation/excluder-devices-on-commercial-crab-traps/>.

Wijnstekers, W. 2003. *The evolution of CITES: A reference to the Convention on International Trade in Endangered Species of Wild Flora and Fauna*. 7th Edition. Geneva, Switzerland: CITES Secretariat. 588 pp.

Willey, L.L., and P.R. Sievert. 2012. Notes on the nesting ecology of Eastern Box Turtles near the northern limit of their range. *Northeastern Naturalist* 19(3):361–372.

Williams, E.C., Jr., and W.S. Parker. 1987. A long-term study of a Box Turtle (*Terrapene carolina*) population at Allee Memorial Woods, Indiana, with emphasis on survivorship. *Herpetologica* 43:328–335.

Witz, B.W., D.S. Wilson, and M.D. Palmer. 1992. Estimating population size and hatchling mortality of *Gopherus polyphemus*. *Florida Scientist* 55:14–18.

Zylstra, E.R., R.J. Steidel, C.A. Jones, and R.C. Averill-Murray. 2013. Spatial and temporal variation in survival of a rare reptile: A 22-year study of Sonoran desert tortoises. *Oecologia* 173:107–116.

Commission for Environmental Cooperation
700 rue de la Gauchetiere Ouest, bureau 1620
Montreal (Quebec), H3B 5M2 Canada
t 514.350.4300 f 514.350.4314
info@cec.org / www.cec.org