

The Elasmobranch Husbandry Manual: Captive Care of Sharks, Rays and their Relatives

Editors

Mark Smith
Doug Warmolts
Dennis Thoney
Robert Hueter



Published by
Ohio Biological Survey, Inc.

Ohio Biological Survey

Special Publication

ISBN-13: 978-0-86727-152-3

ISBN-10: 0-86727-152-3

Library of Congress Number: 2004115835

Publication Director

Brian J. Armitage

Editorial Committee

Barbara K. Andreas, Ph. D., Cuyahoga Community College & Kent State University

Brian J. Armitage, Ph. D., Ohio Biological Survey

Benjamin A. Foote, Ph. D., Kent State University (Emeritus)

Jane L. Forsyth, Ph. D., Bowling Green State University (Emeritus)

Eric H. Metzler, B.S., The Ohio Lepidopterists

Scott M. Moody, Ph. D., Ohio University

David H. Stansbery, Ph. D., The Ohio State University (Emeritus)

Ronald L. Stuckey, Ph. D., The Ohio State University (Emeritus)

Elliot J. Tramer, Ph. D., The University of Toledo

Literature Citation

Smith, M., D. Warmolts, D. Thoney, and R. Hueter (editors). 2004. The Elasmobranch Husbandry Manual: Captive Care of Sharks, Rays and their Relatives. Special Publication of the Ohio Biological Survey. xv + 589 p.

Cover and Title Page

Illustration by Rolf Williams, The National Marine Aquarium, Rope Walk, Coxside, Plymouth, PL4 0LF United Kingdom

Distributor

Ohio Biological Survey, P.O. Box 21370, Columbus, Ohio 43221-0370 U.S.A.

Copyright

© 2004 by the Ohio Biological Survey

All rights reserved. No part of this publication may be reproduced, stored in a computerized system, or published in any form or in any manner, including electronic, mechanical, reprographic, or photographic, without prior written permission from the publishers, Ohio Biological Survey, P.O. Box 21370, Columbus, Ohio 43221-0370 U.S.A.

Layout and Design: Brian J. Armitage, Ohio Biological Survey

Printing: The Ohio State University, Printing Services, Columbus, Ohio

Ohio Biological Survey
P.O. Box 21370
Columbus, OH 43221-0370
<ohiobiosurvey@sbcglobal.net>
www.ohiobiologicalsurvey.org

11-2004—1.5M

Chapter 3

Collecting Elasmobranchs: Legislation, Permitting, Ethics, and Commercial Collectors

JOSEPH M. CHOROMANSKI

*Ripley Aquariums
Ripley Entertainment, Inc.
7576 Kingspointe Parkway, Suite 188,
Orlando, FL 32819, USA.
E-mail: jchoromanski@ripleys.com*

Abstract: A number of international and national organizations, both governmental and non-governmental, have jurisdiction or influence over the management of marine fisheries, and hence, over the legal collection of elasmobranchs. It is the responsibility of aquarium staff to understand and adhere to any legislation, both international and regional, relevant to their elasmobranch collections. In addition, it is imperative that public aquariums and commercial collectors work closely with regulatory agencies to help educate them about the unique nature of our business. Regulatory agencies should be regarded as partners and not adversaries. Information learned through collection activities should be shared with regulatory agencies, whether required by law or not, to help build healthy relationships, dispel misconceptions, and improve a mutual understanding of the species in question. Zoos and aquariums justify the collection and display of wild animals by the educational, research, and conservation goals achieved. A frequently asked and basic ethical question is as follows: Do the benefits of a quality display of elasmobranchs at a professionally-operated public aquarium, having a strong educational, research, and conservation mission, outweigh the cost to individual animal welfare? We, as an industry, believe that they do. In addition to this basic question, other, more specific ethical concerns should be considered when formulating an elasmobranch collection for an aquarium. Is the species difficult to keep? Is it appropriate and permissible to release the species should it outgrow an exhibit? Is the species at threat of extinction in the wild and therefore protected? In seeking to better understand and meet the aforementioned ethical considerations, the public aquarium community has recourse to many professional zoo and aquarium associations.

Sharks, skates, rays (the elasmobranchs), and chimeras together comprise the class Chondrichthyes, or the cartilaginous fishes, a group of over 1,000 species of mostly marine fishes. Much of the legislation (e.g., commercial fishery regulations, etc.) that regulates the harvest of elasmobranchs encompasses a far greater number of individuals and species than the international aquarium community would ever conceivably display. Legislative information specific to the commercial fishery can be found elsewhere (Camhi, 1998; Camhi et al., 1998; Camhi, 1999; Anon., 2001a).

This chapter focuses on aspects of legislation and permitting, for as many countries as possible, as it pertains to elasmobranch species that are

commonly collected and displayed by public aquariums. Due to space limitations, the chapter centers on legislation and permitting for collecting elasmobranchs. It does not address legislation and permitting, where required, for the possession or importation of elasmobranch species, as this information is readily available from governmental agencies. Likewise, the chapter does not detail fisheries management regulations (i.e., regulations to govern the commercial take of elasmobranchs for consumptive purposes), but rather addresses those regulations that may potentially affect the future collection of a species for public display. The chapter concludes by briefly discussing ethical considerations related to the collection and display of elasmobranchs, and the use of commercial collectors.

LEGISLATION AND PERMITTING

Many readers of this chapter will only want to know what paperwork is required to collect the species they desire and how to go about getting the proper permits. Before this can be addressed, it must be understood that the information provided in this chapter is current as of mid-2003 and is unavoidably a snapshot in time. Only a few countries (e.g., Australia, Canada, New Zealand, South Africa, and the United States) have fishery management plans for specific shark fisheries. As such, specific legislation and permitting regulations for only a few countries are detailed in this chapter. Fishery regulations often change, and curators and commercial collectors must remain informed and up-to-date about this rapidly changing arena. The information provided herein serves as a starting point for researching legislative and permitting changes that will no doubt occur over time.

International regulations

Elasmobranch collection is regulated to varying extremes throughout the world, ranging from outright prohibition, to taking only certain species, to no regulation whatsoever. At present, there are no international management programs or regulations that effectively address the capture of sharks (Anon., 2001a). Most sharks and many rays are highly migratory and routinely cross political boundaries (Camhi et al., 1998), making management challenging.

FAO

During 1999, the Food and Agriculture Organization of the United Nations (FAO), Committee on Fisheries (COFI), adopted the International Plan of Action for the Conservation and Management of Sharks (IPOA). The IPOA (Anon., 1999a), building on the FAO Code of Conduct for Responsible Fisheries, encompasses all elasmobranch fisheries and calls on member nations to develop National Plans of Action (NPOA) for the conservation and management of sharks. Although the IPOA applies to all States, entities, and fishers, participation is voluntary. As of late 2002, only two NPOAs have been completed (i.e., for the USA and Japan) out of 87 shark-fishing nations, 18 of which are considered major fishing nations (i.e., landing >10,000 metric tons year⁻¹). Several States have draft NPOAs (i.e., Australia and the EU) and several more are

reported to be in preparation (e.g., South Africa) (Anon., 2001a; Anon., 2002a; Anon., 2002b; Anon., 2002c; Smale, pers. com.). Readers are urged to study detailed information about the IPOA, available at the FAO website (www3).

CITES

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is an agreement that provides for the protection of certain species against over-exploitation through international trade. Under CITES, species are listed in appendices according to their conservation status. Appendix I species are considered to be threatened with extinction, and international trade for commercial purposes is generally not permitted. Appendix II species are not necessarily now threatened with extinction, but may become so if trade is not strictly regulated. Appendix III includes species that any party (i.e., signatory country to CITES) has identified as being subject to regulation within its jurisdiction, to prevent or restrict exploitation, and is seeking cooperation in the control of the trade of that species. Species can only be added, removed, or transferred between Appendix I and II during regular (2-3 year) meetings of the Conference of Parties (COP) or by emergency postal procedures, whereas species can be added or removed from Appendix III by any party at any time (www4).

Prior to 2001, a number of elasmobranch species, including all of the sawfishes (Family: Pristidae), were proposed for listing on CITES Appendices I or II, but were not accepted (Anon., 2001a). In response, the basking (*Cetorhinus maximus*) and great white (*Carcharodon carcharias*) sharks were listed in Appendix III by the United Kingdom and Australia, respectively. During the 12th COP in 2002, Appendix II proposals were approved from India and the Philippines for the whale shark (*Rhincodon typus*), and from the United Kingdom for the basking shark (Table 3.1). Not only do these listings represent the first time elasmobranch species have been included in CITES Appendix II, they also represent the only international trade regulation affecting elasmobranchs. An Appendix II listing does not end or restrict trade as long as the exporting country can demonstrate that trade in a listed species, or its products, is not detrimental to the survival of that species. Appendix II listing requires data collection and reporting by any of the 160 member countries involved in the trade of listed species.

Table 3.1. Conservation and permitting status of elasmobranchs showing: Convention on the International Trade in Endangered Species (CITES) status; World Conservation Union (IUCN) Red List status; the American Fisheries Society (AFS) status list of Elasmobranch Species Distinct Population Segments; species regulated by the United States Federal Government National Marine Fisheries Service (NMFS); species regulated by the Shark Advisory Group (SAG) of the Australian Department of Agriculture, Fisheries and Forestry; and species regulated by the Marine Living Resources Act (MLRA) of the South Africa National Government.

Scientific Name	Common Name	CITES	IUCN Red List Status ^{a,b,c}	AFS (N. Am.) ^{d,e}	NMFS (USA) ^f	SAG (AUS) ^g	MLRA (SA) ^h
<i>Aetobatus narinari</i>	spotted eagle ray		DD			LR/lc	
<i>Alopias superciliosus</i>	bigeye thresher shark				P		
<i>Alopias vulpinus</i>	thintail thresher shark		DD			DD (A)	
<i>Amblyraja radiata</i>	thorny skate			VU (US) + NA (CA)			
<i>Anoxypristis cuspidata</i>	knifetooth sawfish		EN A1acde+2cde			VU (A)	
<i>Bathyraja abyssicola</i>	deepsea skate		DD				
<i>Callorhynchus milii</i>	ghost shark					(A)	
<i>Carcharhinus altimus</i>	bignose shark				P		
<i>Carcharhinus amblyrhynchoides</i>	graceful shark		LR/nt			LR/nt	
<i>Carcharhinus amblyrhynchus</i>	gray reef shark		LR/nt			LR/lc	
<i>Carcharhinus amboinensis</i>	pigeon shark		DD (LR/nt: SWI)			DD	
<i>Carcharhinus borneensis</i>	Borneo shark		EN C2b				
<i>Carcharhinus brachyurus</i>	copper shark				P	(A)	
<i>Carcharhinus brevipinna</i>	spinner shark		LR/nt (VU A1bd+2d: NWA)			LR/lc	
<i>Carcharhinus galapagensis</i>	Galapagos shark				P		
<i>Carcharhinus hemiodon</i>	Pondicherry shark		VU C2a				
<i>Carcharhinus leiodon</i>	smalltooth shark		VU B1+2c, C2b				
<i>Carcharhinus leucas</i>	bull shark		LR/nt			LR/lc	
<i>Carcharhinus limbatus</i>	blacktip shark		LR/nt (VU A1bcd+2cd: NWA)			DD	
<i>Carcharhinus longimanus</i>	oceanic whitetip shark		LR/nt			LR/nt	
<i>Carcharhinus melanopterus</i>	blacktip reef shark		LR/nt			LR/nt	
<i>Carcharhinus obscurus</i>	dusky shark		LR/nt (VU A1abd: NWA + GM)	VU (WA + EP)	P	LR/nt	
<i>Carcharhinus perezi</i>	Caribbean reef shark				P		
<i>Carcharhinus plumbeus</i>	sandbar shark		LR/nt (LR/cd: NWA)			LR/nt (A)	
<i>Carcharhinus porosus</i>	smalltail shark				P		
<i>Carcharhinus signatus</i>	night shark			VU (WA)	P		
<i>Carcharias taurus</i>	sand tiger shark		VU A1ab+2d	VU (WA)	P	EN (P)	AN 4
<i>Carcharodon carcharias</i>	great white shark	APP III	VU A1cd+2cd	CD (WA + EP)	P	VU (P)	AN 5
<i>Centrophorus granulosus</i>	gulper shark		VU A1abd+2d			DD	
<i>Centrophorus harrissoni</i>	dumb gulper shark					EN (EPBCA)	
<i>Centrophorus uyato</i>	little gulper shark					VU (EPBCA)	
<i>Cetorhinus maximus</i>	basking shark	APP II	VU A1ad+2d (EN A1d: NP + NEA)	VU (EP) + CD(WA)	P	DD (P)	
<i>Dalatias licha</i>	kitefin shark		DD (LR/nt: NEA)			DD (A)	
<i>Dasyatis fluviatorum</i>	estuary stingray					LR/nt	
<i>Dasyatis garouaensis</i>	smooth freshwater stingray		VU B1+2cde, C2b				

a. 2000 IUCN Red List status categories: Critically Endangered (CR); Endangered (EN); Vulnerable (VU); Lower Risk (LR) where nt = near threatened, cd = conservation dependent and lc = least concern; and Data Deficient (DD).

b. 2000 IUCN Red List status criteria: Upper case letters, numbers and lower case letters adjacent to the category listings (e.g., A1abd+2d) refer to specific criteria defined for each red list category. The detailed descriptions of these criteria are available on the red list web site (www.iucn.org).

c. 2000 IUCN Red List status regions: Australasian subpopulation (AU); Brazilian subpopulation (BR); Eastern Pacific subpopulation (EP); Gulf of Mexico (GM); Northeast Atlantic subpopulation (NEA); North Pacific subpopulation (NP); Northwest Atlantic subpopulation (NWA); Southwest Atlantic subpopulation (SWA); Southwest Indian Ocean subpopulation (SWI); and Thailand subpopulation (TH).

d. AFS (North America) categories: Endangered (ED); Threatened (T); Vulnerable (VU); Conservation Dependant (CD); Not at Risk (NR); and not assessed (NA).

e. AFS (North America) regions: Canada (CA); Eastern Pacific (EP); Gulf of California (GC); Gulf of Mexico (GM); United States territorial waters (US); and Western Atlantic (WA).

f. NMFS (USA) categories: Endangered under the U.S. Endangered Species Act (E); Possession is prohibited in commercial and recreational fisheries (P).

g. SAG (Australia) categories: Categories are the same as used by the 2000 IUCN Red List (see footnote "a"). Parenthetical annotations: Protected in some state, territory, and/ or Commonwealth waters (P); Potentially of concern given consistent high catch rates in non-target fisheries (A); Being considered for listing as a threatened species under the Environment Protection and Biodiversity Conservation Act (EPBCA).

h. MLRA (South Africa) categories: Annexure 4 (non- saleable recreational list), fishers are allowed 10 in total from this list but no more than 5 of any one species (AN 4); Annexure 5 (specially protected list), no take allowed (AN 5).

Table 3.1 (continued). Conservation and permitting status of elasmobranchs showing: Convention on the International Trade in Endangered Species (CITES) status; World Conservation Union (IUCN) Red List status; the American Fisheries Society (AFS) status list of Elasmobranch Species Distinct Population Segments; species regulated by the United States Federal Government National Marine Fisheries Service (NMFS); species regulated by the Shark Advisory Group (SAG) of the Australian Department of Agriculture, Fisheries and Forestry; and species regulated by the Marine Living Resources Act (MLRA) of the South Africa National Government.

Scientific Name	Common Name	CITES	IUCN Red List Status ^{a,b,c}	AFS (N. Am.) ^{d,e}	NMFS (USA) ^f	SAG (AUS) ^g	MLRA (SA) ^h
<i>Dasyatis laosensis</i>	Mekong stingray		EN A1cde+2cde, B1+2ce				
<i>Dipturus batis</i>	skate		EN A1abcd+2bcd				
<i>Dipturus laevis</i>	barndoor skate		VU A1bcd	VU (CA + WA)			
<i>Furgaleus macki</i>	whiskery shark		LR/cd			LR/cd	
<i>Galeocerdo cuvier</i>	tiger shark		LR/nt			LR/lc	
<i>Galeorhinus galeus</i>	tope shark		VU A1bd (LR/cd: AU)			LR/cd (A)	
<i>Glyphis gangeticus</i>	Ganges shark		CR A1cde+2cde, C2b				
<i>Glyphis glyphis (species A)</i>	spear-tooth shark		EN C2a			CR (P)	
<i>Glyphis sp. (species C)</i>	northern river shark					EN (P)	
<i>Haploblepharus edwardsii</i>	puffadder shyshark		LR/nt				
<i>Haploblepharus fuscus</i>	brown shyshark		LR/nt				
<i>Hemirhamphus leucoperiptera</i>	whitfin tope shark		EN B1+2ce, C2b				
<i>Heteroscyllium colcloughi</i>	bluegray carpet shark		VU C2b			VU (EPBCA)	
<i>Hexanchus griseus</i>	bluntnose sixgill shark		LR/nt		P	DD	
<i>Hexanchus nakamurai</i>	bigeye sixgill shark				P		
<i>Himantura chaophraya</i>	freshwater stingray		VU A1bcde+2ce (CR A1bcde+2ce: TH)			VU	
<i>Himantura fluviatilis</i>	Ganges stingray		EN A1cde+2cde, B1+2c				
<i>Himantura oxyrinchus</i>	marbled whipray		EN B1+2c				
<i>Himantura signifer</i>	white-rimmed whipray		EN B1+2c				
<i>Hydrolagus ogilbyi</i>	Ogilby's ghost shark					(A)	
<i>Hypogaleus hyugaensis</i>	blacktip tope shark		LR/nt			LR/lc	
<i>Isurus oxyrinchus</i>	shortfin mako		LR/nt			LR/lc (A)	
<i>Isurus paucus</i>	longfin mako				P		
<i>Lamna ditropis</i>	salmon shark		DD				
<i>Lamna nasus</i>	porbeagle		LR/nt (VU A1bd: NEA) (LR/cd: NWA)			LR/lc (A)	
<i>Leptocharias smithii</i>	barbeled hound shark		LR/nt				
<i>Manta birostris</i>	giant manta					LR/lc	
<i>Megachasma pelagios</i>	megamouth shark		DD			DD (P)	
<i>Mobula mobular</i>	devil fish		VU A1cd				
<i>Mustelus antarcticus</i>	gummy shark		LR/cd			LR/lc (A)	
<i>Mustelus canis</i>	dusky smooth-hound		LR/nt				
<i>Mustelus lenticulatus</i>	spotted estuary smooth-hound		LR/cd				
<i>Negaprion brevirostris</i>	lemon shark		LR/nt				
<i>Notorynchus cepedianus</i>	broadnose sevengill shark		DD (LR/nt: EP)		P	DD (A)	
<i>Odontaspis ferox</i>	smalltooth sand tiger shark					LR/nt (P)	
<i>Odontaspis noronhai</i>	bigeye sand tiger shark		DD		P		
<i>Orectolobus maculatus</i>	spotted wobbegong					DD	
<i>Orectolobus ornatus</i>	ornate wobbegong					DD	
<i>Poroderma africanum</i>	striped cat shark		LR/nt				AN 4
<i>Poroderma pantherinum</i>	leopard cat shark						AN 4
<i>Potamotrygon brachyura</i>	short-tailed river stingray		DD				
<i>Potamotrygon henlei</i>	bigtooth river stingray		DD				

Table 3.1 (continued). Conservation and permitting status of elasmobranchs showing: Convention on the International Trade in Endangered Species (CITES) status; World Conservation Union (IUCN) Red List status; the American Fisheries Society (AFS) status list of Elasmobranch Species Distinct Population Segments; species regulated by the United States Federal Government National Marine Fisheries Service (NMFS); species regulated by the Shark Advisory Group (SAG) of the Australian Department of Agriculture, Fisheries and Forestry; and species regulated by the Marine Living Resources Act (MLRA) of the South Africa National Government.

Scientific Name	Common Name	CITES	IUCN Red List Status ^{a,b,c}	AFS (N. Am.) ^{d,e}	NMFS (USA) ^f	SAG (AUS) ^g	MLRA (SA) ^h
<i>Potamotrygon leopoldi</i>	white-blotched river stingray		DD				
<i>Potamotrygon motoro</i>	ocellate river stingray		DD				
<i>Prionace glauca</i>	blue shark		LR/nt			LR/lc (A)	
Pristidae	sawfishes (all species)						AN 5
<i>Pristiophorus cirratus</i>	longnose sawshark		LR/nt			LR/cd	
<i>Pristis clavata</i>	dwarf sawfish		EN A1acd+2cd			EN	
<i>Pristis microdon</i>	largetooth sawfish		EN A1bcde+2bcde (CR A1abc+2cd: SEA)			CR (P)	
<i>Pristis pectinata</i>	smalltooth sawfish		EN A1bcd+2cd (CR A1abc+2cd: NWA + SWA)	ED (US + GM)	E	DD	
<i>Pristis perotteti</i>	large-tooth sawfish		CR A1abc+2cd	ED (US + GM + GC)			
<i>Pristis pristis</i>	common sawfish		CR A1abc+2cd				
<i>Pristis zijsron</i>	longcomb sawfish		EN A1bcd+2cd			EN (A)	
<i>Pseudocarcharias kamoharai</i>	crocodile shark		LR/nt			LC/lc	
<i>Raja binoculata</i>	big skate		LR/nt	VU (EP)			
<i>Raja clavata</i>	Thornback ray		LR/nt				
<i>Raja microocellata</i>	Small-eyed ray		LR/nt				
<i>Raja sp. L</i>	Maugae skate		EN B1+2c			EN (EPBCA)	
<i>Rhincodon typus</i>	whale shark	APP II	VU A1bd+2d	CD (USA + AT + GM); NR (GC)	P	DD (P)	
<i>Rhinobatos horkeli</i>	Brazilian guitarfish		CR A1bd+2bd				
<i>Rhizoprionodon porosus</i>	Caribbean sharpnose shark				P		
<i>Rhynchobatus djiddensis</i>	giant guitarfish		VU A1bd+2d			LR/lc	
<i>Schroederichthys biviuis</i>	narrowmouthed catshark		DD				
<i>Scoliodon laticaudus</i>	spadenose catshark		LR/nt				
<i>Scyliorhinus capensis</i>	yellowspotted catshark		LR/nt				
<i>Scyliogaleus queckettii</i>	flapnose houndshark		VU B1+2c, C2b				
<i>Sphyma lewini</i>	scalloped hammerhead		LR/nt			LR/lc	
<i>Sphyma mokarran</i>	great hammerhead		DD			LR/lc	
<i>Sphyma zygaena</i>	smooth hammerhead		LR/nt			LR/lc	
<i>Squalus acanthias</i>	spiny dogfish		LR/nt			LR/lc	
<i>Squatina argentina</i>	Argentine angelshark		DD				
<i>Squatina californica</i>	Pacific angelshark		LR/nt				
<i>Squatina dumeril</i>	sand devil				P		
<i>Squatina guggenheim</i>	angular angelshark		VU A1bd+A2d (EN A1bd+2d: BR)				
<i>Squatina occulta</i>	hidden angelshark		EN A1abd+A2d				
<i>Squatina squatina</i>	angelshark		VU A1abcd+A2d				
<i>Taeniura lymma</i>	bluespotted ribbontail ray		LR/nt			LR/lc	
<i>Triaenodon obesus</i>	whitetip reef shark		LR/nt			LR/lc	
<i>Triakis acutipinna</i>	sharpfin houndshark		VU C2b				
<i>Triakis megalopterus</i>	sharptooth houndshark		LR/nt				AN 4
<i>Triakis semifasciata</i>	leopard shark		LR/cd				
<i>Urogymnus asperimus</i>	porcupine ray		VU A1bd, B1+2bcd			LR/nt	
<i>Urogymnus ukpam</i>	thorny freshwater stingray		EN B1+2abcd				

Conservation assessment lists

The conservation status of many elasmobranch species has been assessed by a variety of non-governmental (NGO) conservation agencies, in the form of classification lists. These lists have no governmental or regulatory authority per se, however, they often form the basis of existing or future fishery regulations.

IUCN Red list of Threatened Species™

The IUCN (World Conservation Union) brings together states, government agencies, and a diverse range of NGOs, in a unique world partnership with over 980 members in some 140 countries. The IUCN's mission is "...to influence, encourage, and assist societies throughout the world to conserve the integrity and diversity of nature and to ensure that any use of natural resources is equitable and ecologically sustainable..." (www5). Although the IUCN has no regulatory power, it does seek to influence the implementation of international conservation conventions such as CITES, World Heritage, and the Convention on Biological Diversity.

The IUCN Red List of Threatened Species™ is now widely recognized as the most comprehensive, apolitical global system for evaluating the conservation status of plant and animal species. From small beginnings, almost 30 years ago, the IUCN Red List has grown in size and complexity. The IUCN's scientifically rigorous approach to determining risk of extinction, introduced in 1994 and applicable to all species and infra-specific taxa, has virtually become a world standard (Anon., 1994). These criteria were updated in 2001 (Anon., 2001b), in part to address concerns over the application of earlier criteria to commercially exploited marine fishes, although most elasmobranch evaluations are still based on the criteria established in 1994. The last major printed publication of the IUCN Red List was in 2000 (Hilton-Taylor, 2000). Since 2000, the IUCN Red List has been updated annually on their official web site (www8). The next printed update of the IUCN Red List is planned for 2004.

The main purpose of the IUCN Red List is to catalogue and highlight those taxa that are at risk of global extinction (i.e., "critically endangered", "endangered", and "vulnerable"). The IUCN Red List includes information on taxa that are categorized as "extinct or extinct in the wild"; "data deficient" (i.e., taxa that cannot be evaluated

because of insufficient information); and "near threatened" (i.e., taxa that are close to threatened thresholds). The IUCN Red List's regular program of updates and publications provides a means of monitoring changes in the status of listed species.

Between 1996 and 2000, the number of fish species on the IUCN Red List increased dramatically, largely as a result of an improved coverage of the sharks and rays. The 1996 IUCN Red List (Baille and Groombridge, 1996) included 32 species of elasmobranchs, while the 2000 IUCN Red List (Hilton-Taylor, 2000) included 95 species (Table 3.1). A review of the IUCN Red List assessments for all chondrichthyan fishes is scheduled for 2004. [Author's Note (September, 2004): The current web-based IUCN Red List now contains 185 species of elasmobranchs (www 8).]

AFS

Musick et al. (2000), under the auspices of the American Fisheries Society (AFS), published the first recognized list of marine fish species and marine fish stocks at risk of extinction (MSRE). The AFS list identified 82 species or populations categorized as "vulnerable", "threatened", or "endangered" in North American waters, 22 of which may be "vulnerable" to global extinction. The status of these organisms was determined by applying risk criteria (i.e., rarity, small range limits and endemism, specialized habitat requirements, population resilience to decline, and fecundity) developed from peer-reviewed knowledge and expert scientific opinion. Most stocks faced more than one risk factor, but life history limitations (e.g., low or very low reproductive capacity) were considered particularly important.

A fish stock refers to a group of fish that can be treated as a single unit for management purposes. In identifying which units were at risk, Musick et al. (2000) employed the concept of distinct population segments (DPSs). DPSs were defined as populations markedly separated from other populations of the same organism, as a consequence of significant physical, physiological, ecological, or behavioral factors (Anon., 1996).

Fisheries scientists believe it is important to recognize threatened fish populations early in their decline and implement conservation measures that will preclude further population reduction or extinction. AFS categories deal with

extinction risk, and not growth or recruitment, except where over-fishing threatens recruitment and thus a DPS with extinction. AFS recognizes the following categories of risk: (1) “endangered”, i.e., high risk of extinction in the wild in the immediate future (years); (2) “threatened”, i.e., not endangered but facing risk of extinction in the near future (decades); (3) “vulnerable” (special concern), i.e., not endangered or threatened severely, but at possible risk of falling into one of these categories in the near future; (4) “conservation dependent”, i.e., reduced but stabilized or recovering under a continuing conservation plan; and (5) “not at risk”, i.e., not at apparent risk of extinction. Of the 82 species listed in the AFS publication (Musick et al., 2000), 11 are elasmobranch species (Table 3.1).

The constraints of lists

Although conservation assessment lists are intended to help protect and conserve elasmobranch species, and represent considerable effort and research, they present a risk to public aquariums.

Firstly, there is the issue of non-standardized, if not confusing, nomenclature. For example, the IUCN Red List classes a species as “threatened” if it falls into any of the “critically endangered”, “endangered”, or “vulnerable” categories. Similarly, the U.S. Endangered Species Act (ESA) classifies species as either “threatened” or “endangered”, based on population status, but it is common for ESA-assessed animals to be referred to in general as simply “endangered”. In addition, the AFS list has adopted similar, but not identical, classifications as the IUCN Red List.

Secondly, there is the issue of confusing management units when distinguishing between a species, a distinct population, DPSs, or stocks. Most non-scientific individuals do not differentiate between the various forms of “endangered” and/or “threatened”, nor between DPS’s and species. This confusion can lead to bad legislation and especially confusing law enforcement. Aquariums have already observed this problem with the green sea turtle (*Chelonia mydas*), listed by ESA as “endangered” but having a Caribbean population classified under the less restrictive “threatened”.

Thirdly, well intended fishery regulators may adopt conservation recommendations and incorporate assessment lists verbatim, creating blanket

legislation that has no exemption for the collection and live display of elasmobranchs. Sweeping interpretations of this nature can preclude the opportunity of presenting important conservation messages to the public, through engaging and educational live displays.

It is essential that aquarists and fishery managers familiarize themselves with the different definitions used for, and the rationale behind, all conservation assessment listings. In addition, it is important to understand the difference between advisory, non-statutory lists (e.g., the IUCN Red List, the AFS MSRE, etc.) and lists enacted through legislation (see below).

National regulations: USA

Atlantic FMP, Shark FMP, and EFPs

The Magnuson-Stevens Fishery Conservation and Management Act (M-S Act) of 1976, is the primary legislation governing the conservation and management of marine fisheries within the U.S. Exclusive Economic Zone (EEZ). The M-S Act requires the National Marine Fisheries Service (NMFS), and eight regional fishery management councils (i.e., New England, Mid-Atlantic, South Atlantic, Gulf of Mexico, Caribbean, Pacific, North Pacific, and Western Pacific), to analyze fisheries under their jurisdiction and develop Fishery Management Plans (FMPs). In addition, NMFS works with three interstate marine fisheries commissions (i.e., the Atlantic States, Gulf States, and Pacific States) to monitor fisheries management at the state level, and to coordinate fishery issues that cross over state and federal boundaries. In general, waters under the jurisdiction of individual coastal states extend from the shoreline to a limit of three nautical miles (nine nautical miles in the case of Texas, the west coast of Florida, and Puerto Rico). Federally managed waters continue offshore from state waters to a 200 nautical mile limit (except where intercepted by the EEZ of another country). Management of elasmobranchs in state waters falls under the control of that state’s regulatory authority; usually the marine division of the respective fish and wildlife department (Anon., 2001a).

In the early 1980’s, directed Atlantic shark fisheries expanded rapidly when shark meat was marketed as an acceptable alternative to tuna and swordfish. Shark landings increased by almost 300% between 1985 and 1994. This trend was identified by the early 1990’s and the first federal

shark fishery management plan was developed by NMFS in 1993. The 1993 Fishery Management Plan for Sharks of the Atlantic Ocean (Shark FMP) separated 39 species of sharks into three groups (i.e., large coastal sharks or LCS, small coastal sharks or SCS, and pelagic sharks or PS) and catch limits were imposed (Anon., 1993; Anon., 2001a). The three categories were based on the fishery in which the sharks were caught, rather than biological factors. LCS consisted of targeted commercial and sport fished species; SCS consisted of largely near-shore species, caught primarily by sport fishers and as by-catch of shrimp, long-line, and gillnet fisheries; and PS, offshore and deepwater species, were harvested primarily as by-catch of the tuna and swordfish long-line fisheries, and were also targeted by sport fishers (www9).

In 1997, NMFS prohibited the possession of five species of shark, the great white, whale, basking, sand tiger (*Carcharias taurus*), and bigeye sand tiger (*Odontaspis noronhai*) sharks. These species were identified as highly susceptible to overexploitation and prohibition was a precautionary measure to ensure a directed fishery did not develop (Anon., 2001a). From this point forward, an Exempted Fishing Permit (EFP) was required to collect sand tiger sharks, the only species of the five prohibited species to be routinely displayed by aquariums. During the same year (1997), NMFS added dusky (*Carcharhinus obscurus*), night (*Carcharhinus signatus*), and sand tiger sharks to the candidate species list for possible inclusion under the Endangered Species Act (see ESA below).

In 1999, NMFS added two categories (i.e., Prohibited Species, and Deepwater and Other Sharks) to the Shark FMP (Anon., 1999b; Anon., 2001a). NMFS then issued the Final Fishery Management Plan for Atlantic Tunas, Swordfish, and Sharks (Atlantic FMP). The retention of an additional 14 shark species was prohibited, bringing the total to 19 protected species (Table 3.1). In addition, the new Atlantic FMP imposed an annual catch quota of 60 metric tons whole weight (43 metric tons dressed weight) on sharks intended for display in public aquariums. This figure represents a tiny fraction of the annual commercial fishery catch quota of 2,028 metric tons dressed weight, broken down as follows:

1. Large coastal sharks (LCS), including (a) ridgeback species, i.e., the sandbar (*Carcharhinus plumbeus*), silky (*Carcharhinus falciformis*), and tiger (*Galeocerdo cuvier*) sharks: 620 metric tons; and (b) non-ridgeback species, i.e., the blacktip (*Carcharhinus limbatus*), spinner (*Carcharhinus brevipinna*), lemon (*Negaprion brevirostris*), bull (*Carcharhinus leucas*), and nurse (*Ginglymostoma cirratum*) sharks, and smooth (*Sphyrna zygaena*), scalloped (*Sphyrna lewini*), and great (*Sphyrna mokarran*) hammerhead sharks: 196 metric tons.
2. Small coastal sharks (SCS), including the Atlantic sharpnose (*Rhizoprionodon terraenovae*), blacknose (*Carcharhinus acronotus*), finetooth (*Carcharhinus isodon*), and bonnethead (*Sphyrna tiburo*) sharks: 359 metric tons.
3. Pelagic Sharks (PS), including (a) shortfin mako (*Isurus oxyrinchus*), thintail thresher (*Alopias vulpinus*), and oceanic whitetip (*Carcharhinus longimanus*) sharks: 488 metric tons; (b) porbeagle sharks (*Lamna nasus*): 92 metric tons; and (c) blue sharks (*Prionace glauca*): 273 metric tons.

Once shark catch quotas were established in 1993, it immediately became necessary to apply for EFPs when annual catch quotas were exceeded and corresponding fisheries closed for the season. This had a particular impact on LCS species, i.e., there was a demand for LCS species during periods when the fishery had already been closed. It is unclear when the first EFP was issued, but many requests were made between 1993 and 1998. The evolving EFP process, along with a growing list of prohibited species, led to the proposal for a dedicated public display quota in 1999, and a one-time quota of 75 sand tiger sharks was established for that year. Data provided by NMFS (Stirratt, pers. com.) indicated that 28 EFPs were requested and issued between 2000 and 2002. A total of 2,793 sharks were requested for public display and 10,577 were authorized (including sharks for research purposes), representing <50% of the annual display quota. The number of sharks actually collected in those same years was 144, representing <1% of the 60 metric ton display quota. NMFS is revising the requirements for EFPs and should release this update in 2004.

Although the status of most shark species in the Pacific Ocean is unknown, NMFS is developing a Pacific Highly Migratory Species FMP which will include certain shark species in California, Oregon, and Washington. Existing FMPs cover certain shark species in Hawaii, Guam, and American Samoa (i.e., the Western Pacific Pelagic Fisheries FMP), and Alaska (i.e., the North Pacific FMP).

ESA

The U.S. Endangered Species Act of 1973 (ESA) provides for the conservation and protection of species which have clear potential for endangerment or extinction throughout all, or a significant portion of, their range, and the conservation of the ecosystems on which they depend. There are two classifications under which a species may be listed. Species determined to be in imminent danger of extinction throughout all of a significant portion of their range are listed as “endangered”. Species determined likely to become endangered in the foreseeable future are listed as “threatened”. A “species” is defined by ESA to mean a species, a subspecies, or, for vertebrates only, a distinct population.

ESA authorizes the following: (1) the determination and listing of species as “endangered” and “threatened”; (2) the prohibition of unauthorized taking, possession, sale, and transport of “endangered” species (Note: The term “take” is defined by ESA to mean harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct. The term “harm” is further defined to mean an act which actually kills or injures wildlife. Such act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering.); (3) the acquisition of land for the conservation of listed species, using land and water conservation funds; (4) the establishment of cooperative agreements and grants-in-aid to states that establish and maintain active and adequate programs for endangered and threatened wildlife and plants; (5) the assessment of civil and criminal penalties for violating the Act or regulations; and (6) the payment of rewards to anyone furnishing information leading to the arrest and conviction for any violation of the Act or any regulation issued thereunder.

In general, the U.S. Fish and Wildlife Service (FWS) coordinates ESA activities for terrestrial and freshwater species, while NMFS is responsible for marine and anadromous species. After a listing petition is filed (i.e., to classify a species as “endangered” or “threatened”), it is decided whether the petition presented substantial information to warrant listing. If so, NMFS conducts a status review of the species, initiated by a public solicitation for information, and data relevant to population size and life history of the species are considered (Anon.,

2002d). A final decision must be made within one year of issuance of the proposal. NMFS (or FWS) can initiate a status review without a petition.

A species is listed if it is “threatened” or “endangered” due to any of the following five factors: (1) present or threatened destruction, modification, or curtailment of its habitat or range; (2) overuse for commercial, recreational, scientific, or educational purposes; (3) disease or predation; (4) inadequacy of existing regulatory mechanisms; and (5) other natural or man-made factors affecting its continued existence. After a species has been listed, a recovery plan is prepared which identifies conservation measures to help the species recover. In addition, ESA requires that all federal agencies use their authorities to conduct conservation programs and to consult with NMFS (or FWS) concerning the potential effects of their actions on any species listed under the act.

Barndoor skates (*Dipturus laevis*), common (*Pristis pristis*) and smalltooth (*Pristis pectinata*) sawfishes, and sand tiger, dusky, and night sharks have all been added to the NMFS candidate list for threatened and endangered species, due principally to large documented declines caused by over-fishing (Diaz-Soltera, 1999). A candidate species is, as the name implies, a candidate for listing under the Endangered Species Act (ESA). More specifically, a candidate species is a species or vertebrate population for which reliable information is available that suggests a listing under the ESA may be warranted. There is no mandatory federal protection required under ESA for a candidate species, however NMFS urges voluntary protection for such species. [Author’s note (September, 2004): To better reflect the purpose of the NMFS candidate list, candidate species are now considered “Species of Concern” (64 Federal Register 19975 - April 15, 2004). Only those species under active consideration for ESA listing are referred to as “Candidate Species.” Neither status carries procedural or substantive protection under the ESA.]

The smalltooth sawfish, a popular aquarium species, was added to the ESA candidate species list in 1991, removed in 1997, and reinstated in 1999. In November of 1999, NMFS received a petition from the Center for Marine Conservation requesting that the smalltooth sawfish be listed as endangered under ESA. NMFS completed a status review of the smalltooth sawfish in December 2000 and published a proposed rule to list the U.S. population of this species as endangered under ESA on 16 April 2001

(www10). On 1 April 2003, the smalltooth sawfish was finally listed as an endangered species under ESA, the first elasmobranch species to be so listed (Anon., 2003). In September 2002, a separate petition to list the barndoor skate was ruled as "...not warranted at this time..." (Anon., 2002d). The barndoor skate remains on the ESA candidate species list.

State legislation and the ASMFC

Every coastal state in the USA has some form of marine fisheries unit within the state agency responsible for fish and wildlife management. Each state has different regulations and permitting requirements governing the collection or fishing of elasmobranch species, however, many states are beginning to follow federal regulations (i.e., NMFS), especially with regard to prohibited species. Some states even require collectors to obtain a NMFS EFP as a prerequisite to applying for a permit within their state.

In the past few years, some state agencies have become concerned about the collection activities of public aquariums and commercial collectors. In particular, state agencies have been concerned that some organizations have acquired permits from more than one state, as well as the federal government, and viewed this activity as double dipping, i.e., the potential to collect greater numbers of animals by requesting permits from more than one jurisdiction. In reality, aquariums have applied for permits from different geographical regions to provide collection flexibility (i.e., allowing for collection during convenient times where animals might best be found). Regardless, agencies in some states, unconvinced of the best intentions of public aquariums, requested that shark collection permitting be coordinated by the interstate Atlantic States Marine Fisheries Commission (ASMFC).

The ASMFC was formed by the 15 Atlantic coastal states (Maine to Florida) in 1942 to assist the management and conservation of shared coastal fishery resources under an interstate compact. In 1998, the policy board requested that the ASMFC investigate and consider options for enhancing the management of sharks in state waters. In 1999, workshops (technical and policy) were held to collect state-by-state information on shark fisheries, review the federal FMP, and develop options for possible shark management in state waters by the ASMFC. Although no consensus was reached, attendees agreed that the

Commission should move forward with the development of a shark FMP. In 2001, the management and science committee of the ASMFC met with NMFS to review the database detailing permits issued for scientific and display purposes, and to discuss the effects of removing permitted animals from wild populations.

At the time of writing, NMFS would like to pursue some sort of umbrella exempted fishing permit between NMFS and the ASMFC states, to facilitate enforcement (White, pers. com.). The exact mechanism is unclear, but if a single permit were valid for both state and federal waters, it would help assuage fears of double dipping. In addition, the ASMFC has invited two aquarium representatives, via the American Zoo & Aquarium Association (AZA), to sit on their newly formed shark permit workgroup. As yet, there have not been permitting problems or concerns with states along the Gulf of Mexico or the Pacific coastal states. No regional shark management plans are in effect for these areas.

National regulations: Australia

Management responsibility and jurisdiction for Australian marine resources, including sharks, are shared between the six states, the Northern Territory, and the Australian Federal Government (Commonwealth). The states and territories of Australia have jurisdiction over waters out to 3 nautical miles, and the Commonwealth has jurisdiction for waters outside these limits to the edge of a 200 nautical mile Australian Fishing Zone (AFZ). This system presented challenges to the management of stocks occurring in both inshore and offshore waters, and was resolved by establishing offshore constitutional settlement (OCS) arrangements. Under OCSs, fish stocks can be managed through either a Joint Authority of State and Commonwealth bodies, or under the management of a single jurisdiction throughout a species' range. (Anon., 2001c; Anon., 2002c).

AFMA and SAG

The Australian Fisheries Management Authority (AFMA) is the Commonwealth statutory authority responsible for the sustainable use and efficient management of fishery resources on behalf of the Australian community and key stakeholders. The AFMA manages fisheries within the 200 nautical mile AFZ and, in some cases, by agreement with the Australian states, in state waters. The AFMA

provides fisheries management, and advisory, compliance, and licensing services (www11). AFMA was established in 1992 following the passage through Australian Parliament of the Fisheries Administration and Fisheries Management Acts in 1991. These two pieces of legislation created statutory authority for the day-to-day management of fisheries, vested in the AFMA, and for broader fisheries policies, international negotiations, and strategic issues, administered by the former Department of Primary Industries and Energy, now called the Department of Agriculture, Fisheries, and Forestry Australia (AFFA). AFFA established a Shark Advisory Group (SAG) and together developed Australia's draft NPOA-Sharks, published as a public consultation document in July of 2002 (Anon., 2002c).

While Australia's contribution to the global shark catch is relatively small (<1.5%), sharks are a significant part (~5%) of the total quantity of Australia's wild fish production. Of the over 1,000 species of chondrichthyans identified worldwide nearly 300 species are found in Australian waters and more than half of these are endemic (Anon., 2002c). The Australian shark assessment report identified 178 shark species as caught from Australian waters (Anon., 2001c). Of these sharks, 60 species and five families have been identified as species "of concern" (Table 3.1), including those on the 2000 IUCN Red List, those assessed against IUCN criteria by Pogonoski et al. (2002), and those identified as potentially of concern on the basis of consistently high catch rates recorded in Commonwealth fishing records. Two-thirds of the landings for the 1998-1999 season fell into 15 of the 178 shark species or groups.

Of the 95 chondrichthyan species listed in the 2000 IUCN Red List, 47 occur in Australian waters, with 14 categorized as "threatened" and the remainder listed as "lower risk" (26 species) or "data deficient" (7 species). Of the "threatened" species, five (i.e., of the family Pristidae) are considered "endangered" and nine are considered "vulnerable". An IUCN Red List assessment workshop was held in Australia in March of 2003 in order to review all Australian species of chondrichthyan fishes. The results of this workshop will be incorporated into the IUCN Red List to be published in 2004.

As more information on elasmobranch species becomes available, and more comprehensive risk assessments become possible, the conservation

status assigned to each species will be updated on the IUCN Red List website (www8). There has been some concern that the criteria used for IUCN Red List assessments are not directly applicable to marine species. Although the criteria and categories have been recently updated (Anon., 2001b), most of the current elasmobranch Red List assessments (www8) are still based on criteria from 1994 (Anon., 1994). It is hoped that these assessments will soon be revised using IUCN Red List criteria from 2001 (Anon., 2001b). The conservation status of Australian shark species (Table 3.1) should therefore be regarded as the best currently available, rather than a definitive statement (Anon., 2002c).

EPBCA

There has been a recent boost to the environmental oversight of fisheries management in Australia, primarily by the Commonwealth Department of Environment and Heritage, or Environment Australia (EA). Under the Environment Protection and Biodiversity Conservation Act of 1999 (EPBCA), all Commonwealth-managed fisheries are subject to strategic assessments, while those fisheries managed by states or territories, which impact protected species, may also be assessed (Anon., 2001c). EPBCA strategic assessments are made against the Commonwealth Guidelines for the Ecologically Sustainable Management of Fisheries. The EPBCA came into effect on 16 July 2000, replacing five Commonwealth environment statutes from the 1970's and 1980's, including the Endangered Species Protection Act of 1992. Some states apply additional environmental assessments to fisheries under their jurisdiction, independent of species protected and fisheries assessed under the EPBCA.

At the time of writing, the following elasmobranch species are protected under the EPBCA (www13): (1) the East Coast population of sand tiger or grey nurse sharks and the spartooth shark (*Glyphis* sp. "A"), considered to be "critically endangered"; (2) the northern river shark (*Glyphis* sp. "C"), considered to be "endangered"; and (3) the West coast population of sand tiger or grey nurse sharks, the largetooth sawfish (*Pristis microdon*), the whale shark, and the great white shark, considered to be "vulnerable". It is a requirement of the EPBCA to prepare recovery plans for all "endangered" and "vulnerable" species that occur within Commonwealth jurisdiction. The recovery plan must include research and management

actions necessary to stop the decline of a target species so its chances of long-term survival in the wild are maximized. Of the species currently protected, detailed recovery plans have been prepared for the sand tiger and great white sharks (Anon., 2002e; Anon., 2002f).

State legislation

For species not covered by the EPBCA, state fishery regulations apply. For example, the bigeye sand tiger shark is protected in New South Wales, and the basking and megamouth (*Megachasma pelagios*) sharks are protected in Tasmania. In total, nine elasmobranch species have some form of protection at either the Commonwealth and/or state level where, in general, their collection is prohibited (Table 3.1).

Public aquariums are required to apply for permits, through their respective state fisheries management agency, to collect, hold, and display marine life. Many aquariums therefore obtain animals through licensed commercial collectors. As long as the aquarium has relevant state fisheries permits to hold and display marine life, the commercial collector is responsible for meeting permit requirements to collect the animals from a specific region.

In the event that a public aquarium intends to collect an elasmobranch species directly (e.g., for a species requiring specialized capture or transport techniques) they may be issued a special collection permit. Special collection permits allow for a restricted number of individuals, for the elected species, to be collected and held each year. Permit titles vary between states but in each case there is a permit issued to collect, hold, and display marine life, and a special permit awarded, on application, for the display of protected species (Thorburn, pers. com.).

While most commercial fishing activities are not directed at providing live specimens, there is a growing number of fishermen in Australia who have a real passion and concern for marine life, and are interested in learning how to minimize damage to both fishes and fisheries. Cooperation with these fishermen provides an excellent opportunity to collect smaller, robust species, such as smooth-hounds (*Mustelus* spp.), wobbegong sharks (*Orectolobus* spp.), etc. Of course, collected species must be covered by the fishermen's license and must not be protected under the EPBCA or state Acts.

Aquariums in Australia are unable to purchase specimens from members of the public or amateur fishermen, although they may accept specimens as a donation.

National regulations: South Africa

The coastal environs of South Africa are subject to legislation administered by local, provincial, and federal authorities. Responsibility for coordinating policy specific to the coast and its resources has been delegated to the Department of Environmental Affairs and Tourism, Branch of Marine and Coastal Management (MCM).

The Marine Living Resources Act (MLRA—Act 18 of 1998) was introduced during September of 1998. The MLRA consolidated the Sea Fisheries Act of 1988 and provincial nature conservation ordinances, both of which had previously regulated marine resources. The MLRA was an overdue revision of the Sea Fisheries Act, which benefited some sectors of society and stopped others from gaining access to marine resources. The MLRA allowed previously excluded communities full access to the fishing industry, and prepared the country for free trade and deregulated markets. The guiding principle of the MLRA stresses that the natural marine living resources of South Africa, as well as the environment in which they exist, are a national asset and the heritage of all South African people.

The main thrust of the MLRA and regulation gazette 6284, detailing specific regulations under the MLRA, is that anyone desiring to take a living organism from the marine environment is required to purchase a permit to do so. The user-pays principle generates income which goes toward the research, management, and control of resources. Recreational fishing is regulated via a fee-based permit system and permits may be obtained at any post office. Small-scale and commercial fishing activities are regulated by either the office of the Minister of Environmental Affairs and Tourism, or the Fisheries Transformation Council.

Part 3, Chapter 5 of Regulation Gazette Number 6284 details fishing regulations pertaining to sharks. Protected species are categorized as either annexure 4 ("non-saleable recreational") or annexure 5 ("specially protected") (Table 3.1). Another category, annexure 8 ("exploitable"), refers to species not covered by annexure 4 or 5 whereby a total of 10 elasmobranchs, of no size limit, may be taken.

Public aquariums are required to obtain exemptions to the MLRA through an annual application (or renewal) of permits to the MCM. MLRA exemptions allow aquarium staff to collect and hold more than the normally permitted number of marine taxa. Such exemptions specify that animals shall be used for research or display only, and may not be sold.

In April of 1991, South Africa became the first country to completely protect the great white shark. During 2000, the whale shark was given limited protection status in specific marine protected areas. Any sharks, including those not specifically listed, are afforded protection should they occur within a marine protected area that is closed to fishing or collecting for aquariums.

ETHICS

There are many ethical considerations associated with the maintenance of animals in a captive environment. For an excellent overview, critical analysis, and detailed essays examining both sides of the issue, albeit with a terrestrial zoo perspective, the reader is directed to Norton et al. (1995) and Hutchins et al. (2003).

Aquariums should ensure that all animal exhibits and husbandry procedures are ethically sound, not only because it is appropriate, but also because of a growing public awareness and concern for all animals in captive environments. The powerful public sentiment provoked by captive marine mammals today did not exist 40-50 years ago. As well-intended conservation groups raise the public consciousness about other animal taxa, such as sharks, the public will become increasingly critical of the standards employed in displaying those taxa. Although sharks and stingrays are still feared by the general public in many areas of the world, animal activist groups are becoming increasingly interested in their plight. It is only a matter of time before protesters actively and consistently campaign for improved conditions on behalf of captive elasmobranchs. However, this change in public opinion should not be viewed as a negative influence. Rather, it should be viewed as a testament to the success of aquariums as educational tools. In addition, protestations directed at improving captive conditions should be embraced. We, as an industry, can always improve our exhibits and husbandry techniques, and should capitalize on the opportunity to do so.

Justification

Unlike terrestrial zoos, aquariums must meticulously recreate the marine environment within a very restricted area, providing not only physical space and nutrition, but a slew of carefully controlled chemical and physical parameters. Elasmobranchs are especially difficult to maintain in aquariums, for a variety of reasons (i.e., large size, relatively poorly understood physiology, etc.). As such, our successes at maintaining elasmobranchs, although steadily improving, have been somewhat limited. For the same reasons, captive elasmobranchs have not been studied as extensively, nor maintained for as long, as most terrestrial vertebrates. Thus, alternatives to wild collection, such as captive breeding, have not been widely accomplished.

Zoos and aquariums justify the collection and display of wild animals through the educational, research, and conservation goals achieved. The following ethical question has often been posed: Do the benefits of a quality display of elasmobranchs, at a professionally operated public aquarium, having a strong educational, research, and conservation mission, outweigh the cost to individual animal welfare? We, as an industry, believe that they do. Aquariums benefit society through the presentation of live animal displays and associated public education programs. Aquariums contribute directly to the conservation of aquatic species and their habitat by raising public awareness, by raising funds, and through a direct participation in research activities. Aquariums further advance conservation research by testing new technologies (e.g., satellite pop-off tags, etc.), advancing aquatic animal medicine, developing animal handling techniques, and publishing results stemming from same. By studying elasmobranchs in captivity, and applying that knowledge to their husbandry, aquariums provide valuable and practical information that would be difficult or impossible to gather in the wild (Hutchins et al., 2003).

Protected species

When collecting elasmobranchs, consideration should always be given to the conservation status of a chosen species and requisite permits obtained through appropriate channels. As caretakers of this important taxonomic group, we must, and must be seen to, uphold species management programs and work with

environmental, conservation, and regulatory agencies to police our own industry. Careful ethical consideration should be given to the collection and maintenance of threatened species, in particular where wild populations may suffer as a result of collection activities. Education and conservation benefits must be carefully weighed against risks to wild populations before threatened species are considered for display in an aquarium.

Difficult species

Ethical principals should be applied to the collection and maintenance of shark species that, historically, have not done well in captivity (e.g., species easily damaged in aquariums such as shortfin mako sharks, and those that do not feed readily and can perish after a short period, such as great white sharks). Although it may appear to be ethically unacceptable to collect a species that has not been successfully maintained in an aquarium, to learn more about these difficult species it is necessary to challenge what is known about their husbandry, and this can only be achieved through trial and error. Indeed, as advances have been made in both husbandry and facility design, species previously thought to be problematic or impossible to keep (e.g., tiger sharks) are now being maintained successfully (Marin-Osorno, pers. com.; www14). Experimentation with difficult species should only be considered acceptable if attempts are well researched and planned, experienced personnel are used, and appropriate institutional resources are made available. Specific pre-planned parameters (e.g., minimum space requirements) and clear milestones enabling trials to be aborted before animal health is compromised should be established. In general, an aquarium should never acquire a species that will outgrow their facilities. However, in some rare cases, the risks of acquiring excessively large species may be offset by knowledge gained (e.g., Hewitt, 1984; Ellis and McCosker, 1991).

Releases

Releasing an elasmobranch into the wild, after holding it in captivity, presents a risk to wild populations (i.e., through the introduction of exotic diseases, exotic genetic material, etc.). However, if releases are undertaken correctly (i.e., within the elasmobranchs native range and near the point of collection), with appropriate precautions (i.e., pre-release isolation, medical evaluations,

etc.), and with appropriate governmental approval, such releases can provide valuable scientific information (see Van Dykhuizen et al., 1998). Under the IUCN Species Survival Commission (SSC) Guidelines for Re-introductions (Anon., 1995; www12), this type of release is defined as a “reinforcement” or “supplementation” (i.e., the “...addition of individuals to an existing population of conspecifics...”), as opposed to a “re-introduction” (i.e., “...an attempt to establish a species in an area which was once part of its historical range, but from which it has been extirpated or become extinct...”). Re-introductions are beyond the scope of this chapter, but if considered they should adhere to IUCN SSC guidelines and those of your regional zoological association (see below).

Professional affiliations

Ethical considerations are not normally legislated by governments. Rather, ethics are developed within the culture of the countries in which we live, and often by the professional organizations to which we belong. Most public aquariums belong to a regional zoo and aquarium association, the majority of which abide by a code of professional ethics. These codes address, amongst other issues, the ethical considerations of animal acquisition and disposition through wild collection, commercial suppliers, and trade. A breach of these professional codes can result in some form of penalty to institutions or individuals.

Readers are urged to familiarize themselves with their regional zoo and aquarium association, and correspondingly, their code of ethics. Regional associations include: (1) the American Zoo & Aquarium Association (AZA); (2) the African Association of Zoos and Aquaria (PAAZAB); (3) the Australasian Regional Association of Zoological Parks and Aquariums (ARAZPA); (4) the Canadian Association of Zoos and Aquariums (CAZA); (5) the European Union of Aquarium Curators (EUAC) and the European Association of Zoos and Aquaria (EAZA); (6) the South East Asian Zoos Association (SEAZA); and (7) globally, the World Association of Zoos and Aquariums (WAZA).

Ethical constraints vary between countries and cultures, but presumably we share the same basic goals, i.e., to provide excellent live animal displays for public education and broader conservation purposes, and to breed

endangered or threatened species. By breeding endangered or threatened species we strive to provide self-sustaining captive populations and thereby minimize or eliminate take from the wild, improve knowledge of basic biological parameters, and in some specific cases reinforce wild populations.

COMMERCIAL COLLECTORS

Commercial collectors are defined in this chapter as individuals or companies that collect marine organisms directly from the wild for the purposes of sale to public aquariums. Collection may be done at the specific request of a public aquarium or, in case of non-restricted species, collection may be made in advance with a view to selling the specimens at a later date (i.e., “on speculation”).

Commercial collectors can provide specimen collection, quarantine, and transportation services to those aquariums unable to perform these tasks themselves (i.e., aquariums whose geographic location, lack of expertise or resources, or daily operations and busy programs prevent them from undertaking collecting expeditions). These services are especially important for new aquariums, where staff are preoccupied with other husbandry challenges imposed by unpredictable construction schedules and maturing life support systems. Under such conditions, it becomes difficult for aquarium staff to concentrate on large-scale elasmobranch collection expeditions. Established aquariums may consciously leave the collection of elasmobranchs to commercial collectors, opting to avoid high costs associated with buying and maintaining boats and other equipment. Commercial collectors may provide another service to established aquariums by rapidly replacing animals that have suffered unexpected mortality.

Many reputable and professional commercial collectors have served public aquariums in a laudable manner. Unfortunately, a few commercial collectors have not always subscribed to the same high standards set by their colleagues. At times, these unscrupulous individuals have caused the aquarium community significant difficulty and damage. A few unprincipled collectors have been investigated for illegal activities and public aquariums have been tainted by association. Recent plans to overhaul NMFS’s shark collection permit procedures has been a direct result of such transgressions (Rogers, pers. com.).

Commercial collectors, working in U.S. waters, obtain permits from relevant state and/or federal government agencies, and then collect elasmobranchs as requested by specific aquariums or “on speculation” for future sale. Some commercial collectors have requested permits for a high number of elasmobranchs and subsequently reported collecting far fewer animals. Although innocent, this behavior confuses permitting agencies and creates suspicion; agencies believing that collectors and aquariums are not being entirely honest. In addition, commercial collectors (and public aquariums) have applied for multiple permits covering different jurisdictions, enabling the collection of a given species within limited time frames despite seasonal variations of availability, etc. Again, permitting agencies can be confused by this practice believing that collectors are “double dipping”, i.e., applying for permits from different jurisdictions in order to collect a higher number of animals than legally allowed.

It is imperative that public aquariums and commercial collectors work together with regulatory agencies to educate them about the unique nature of our business. Regulatory agencies should be regarded as partners and not adversaries. Information learned through collection activities should be shared with regulatory agencies, whether required by law or not, to help build healthy relationships, dispel misconceptions, and improve a mutual understanding of regulated species.

It is incumbent upon all aquariums to thoroughly research the reputation and legal status of any commercial collector they choose to contract. Many regulatory agencies are moving toward the practice of issuing collection permits directly to aquariums, and not commercial collectors, especially for restricted or protected species. Aquariums must then contract a commercial collector to obtain the species desired. This practice will make aquariums directly accountable for the activities of contracted commercial collectors. Some U.S. state agencies may go even further, requiring federal permits, and in some cases AZA accreditation, before state permits will be granted to an aquarium.

ACKNOWLEDGEMENTS

I would like to acknowledge the assistance of Craig Thorburn and Malcolm Smale who made valuable contributions toward this chapter.

REFERENCES

- Anon. 1993. Fishery management plan for the sharks of the Atlantic Ocean. NOAA/NMFS, U.S. Department of Commerce, 25 February 1993. 272 p.
- Anon. 1994. The IUCN Red List of Threatened Species™: categories and criteria (version 2.3). International Union for the Conservation of Nature, Gland, Switzerland (www6).
- Anon. 1995. IUCN/SSC Guidelines for re-introductions. International Union for the Conservation of Nature, Gland, Switzerland (www12).
- Anon. 1996. Draft policy regarding controlled propagation of species listed under the Endangered Species Act. United States Fish and Wildlife Service and National Marine Fisheries Service, 7 February 1996. Federal Register 1(26): 4716-4721.
- Anon. 1999a. International Plan of Action for Reducing Incidental Catch of Seabirds in Longline Fisheries. International Plan of Action for the Conservation and Management of Sharks. International Plan of Action for the conservation and management of sharks. Management of Fishing Capacity. Food and Agriculture Organization of the United Nations, Rome, Italy. 26 p.
- Anon. 1999b. Final fishery management plan for Atlantic tuna, swordfish, and sharks. National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, April 1999. 1192 p.
- Anon. 2001a. Final United States national plan of action for the conservation and management of sharks. National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, February 2001. 90 p.
- Anon. 2001b. The IUCN Red List of Threatened Species™: categories and criteria (version 3.1). International Union for the Conservation of Nature, Gland, Switzerland (www7).
- Anon. 2001c. Australian shark assessment report for the Australian national plan of action for the conservation and management of sharks. Shark Advisory Group, Canberra. 207 p.
- Anon. 2002a. The World Conservation Union, Species Survival Commission, Shark Specialist Group and TRAFFIC. Report on implementation of the international plan of action for sharks (IPOA-Sharks): Paper submitted for discussion at the 18th CITES Animals Committee meeting, Costa Rica, 8-12 April, 2002. (www1)
- Anon. 2002b. The World Conservation Union, Species Survival Commission, Shark Specialist Group and TRAFFIC The role of CITES in the conservation and management of sharks. June, 2002. (www2).
- Anon. 2002c. The Australian national plan of action for the conservation and management of sharks - public consultation draft. Shark Advisory Group, Canberra. 59 p.
- Anon. 2002d. Endangered and threatened wildlife and plants; 12-month finding for a petition to list barndoor skate (*Dipturus laevis*) as threatened or endangered. 27 September 2002. Federal Register 67(188): 61055-61061.
- Anon. 2002e. Recovery plan for the Grey Nurse shark (*Carcharias taurus*) in Australia, June 2002. Environment Australia, Canberra. 45 p.
- Anon. 2002f. White Shark (*Carcharodon carcharias*) Recovery Plan, July 2002. Environment Australia, Canberra. 43 p.
- Anon. 2003. Endangered and threatened species; Final endangered status for a distinct population segment of smalltooth sawfish (*Pristis pectinata*) in the United States. 1 April 2003. Federal Register 68(62): 15674-15680.
- Baillie, J. and B. Groombridge (eds.) 1996. The 1996 IUCN Red List of Threatened Animals. International Union for the Conservation of Nature Publications Service Unit, Cambridge, UK. 448 p.
- Camhi, M. 1998. Sharks on the Line: A State-by-State Analysis of Sharks and their Fisheries. National Audubon Society, Living Oceans Program, Islip, New York, USA. 158 p.
- Camhi, M. 1999. Sharks on the Line II: An Analysis of Pacific State Shark Fisheries. National Audubon Society, Living Oceans Program, Islip, New York, USA, 158 p.
- Camhi, M., S. L. Fowler, J. A. Musick, A. Brautigam, and S. V. Fordham. 1998. Sharks and their Relatives: Ecology and Conservation. IUCN/SSC Shark Specialists Group, International Union for the Conservation of Nature, Gland, Switzerland. 39 p.
- Diaz-Soltera, H. 1999. Endangered and threatened species; revision of candidate species list under the Endangered Species Act. Federal Register 64(120): 33166-33467.
- Ellis, R. and J. E. McCosker. 1991. Great White Shark. Harper Collins Publishers, New York, USA. 270 p.
- Hewitt, J. 1984. The great white shark in captivity: A history and prognosis. American Association of Zoological Parks and Aquariums annual conference proceedings, 9-13 September 1984, Miami, Florida, USA. 317-324 pp.
- Hilton-Taylor, C. (ed.). 2000. The 2000 IUCN Red List of Threatened Species. International Union for the Conservation of Nature, Gland, Switzerland. 61 p.
- Hutchins, M., B. Smith, and R. Allard. 2003. In defense of zoos and aquariums: The ethical basis for keeping wild animals in captivity. Journal of the American Veterinary Medical Association. 223(7): 958-966.
- Musick, J. A., M. M. Harbin, S. A. Berkeley, G. H. Burgess, A. M. Eklund, L. Findley, R. G. Gilmore, J. T. Golden, D. S. Ha, G. R. Huntsman, J. C. McGovern, S. J. Parker, S. G. Poss, E. Sala, T. W. Schmidt, G. R. Sedberry, H. Weeks, and S. G. Wright. 2000. Marine, estuarine, and diadromous fish stocks at risk of extinction in North America (exclusive of Pacific salmonids). Fisheries 25(11): 6-30.
- Norton, B. G., M. Hutchins, E. F. Stevens, and T. L. Maple (eds.). 1995. Ethics on the ark: Zoos, animal welfare and wildlife conservation. Washington: Smithsonian Institution Press, USA. 330 p.
- Pogonoski, J. J., D. A. Pollard, and J. R. Paxton. 2002. Conservation overview and action plan for Australian threatened and potentially threatened marine and estuarine fishes, February, 2002. Environment Australia, Sydney. 375 p.
- Van Dykhuizen, G., H. F. Mollet, and J. M. Ezcurra. 1998. Homing behavior of a sevengill shark released from the Monterey Bay Aquarium. California Fish and Game 84(4): 180-181.

PERSONAL COMMUNICATIONS

- Marin-Osorno, R. 2003. Acuario de Veracruz, Veracruz, CP 91170, Mexico.
- Rogers, C. 2002. National Marine Fisheries Service, Highly Migratory Species Management Division, Silver Spring, MD 20910, USA.
- Stirratt, H. 2003. National Marine Fisheries Service, Highly Migratory Species Management Division, Silver Spring, MD 20910, USA.
- Thorburn, C. 2001. Thorburn Consultants Ltd., PO Box 99669, Auckland, New Zealand.
- White, G. 2001. Atlantic States Marine Fisheries Commission, Washington, D. C. 20005, USA.

INTERNET RESOURCES

- www1 www.traffic.org/news/ipoasharks.html
- www2 www.traffic.org/cop12/esf042a.pdf
- www3 www.fao.org/fi/ipa/manage.asp
- www4 www.cites.org
- www5 www.iucn.org
- www6 www.redlist.org/info/categories_criteria1994.html
- www7 www.redlist.org/info/categories_criteria2001.html
- www8 www.redlist.org
- www9 www.flmnh.ufl.edu/fish/organizations/ssg/sharkconswna.htm
- www10 www.nmfs.noaa.gov
- www11 www.afma.gov.au
- www12 www.iunc.org/themes/ssc/pubs/policy/reinte.htm
- www13 www.deh.gov.au
- www14 www.galeocerdo.com