ASSOCIATION OF ZOOS & AQUARIUMS

JELLYFISH
(CNIDARIA/CTENOPHORA)
CARE MANUAL

2nd Edition

CREATED BY THE
AZA AQUATIC INVERTEBRATE TAXONOMIC ADVISORY GROUP
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Jellyfish Care Manual

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Edited by:

Mike Schaadt, Cabrillo Marine Aquarium (Retired)

Authors and Significant Contributors:

Jerry Crow, Curator, Waikiki Aquarium (Retired)
Michael Howard, Senior Aquarist, Monterey Bay Aquarium
Nate Jaros, Curator, Aquarium of the Pacific
Vincent Levesque, Aquarist, Birch Aquarium/Museum at Scripps
Leslee Matsushige, Senior Aquarist, Birch Aquarium/Museum at Scripps
Steve Spina, Assistant Curator, New England Aquarium
Mike Schaadt, Cabrillo Marine Aquarium (Retired)
Nancy Sowinski, Owner, Sunset Marine Labs
Chad Widmer, Biologist, Point Defiance Zoo and Aquarium
Bruce Upton, Senior Aquarist, Monterey Bay Aquarium

Reviewers:

Internal:
Pete Mohan, Akron Zoo, Past AZA Aquatic Invertebrate TAG Chair
Jennifer Janssen, Assistant Curator of Blue Wonders, National Aquarium
Rachel Stein, Associate Director of Animal Husbandry, Maritime Aquarium
Mackenzie Neale, Vancouver Aquarium
Nancy Sowinski, Sunset Marine Labs
Chad Widmer, Monterey Bay Aquarium
Emma Rees (Cartwright), Weymouth Sealife Park
Dr. Poh Soon Chow, Oceanis World

External:
Dr. Rebecca Helm, Brown University
Cheryl L. Ames, U.S. Naval Research Laboratory & Smithsonian National Museum of Natural History

AZA Staff Editors:

Rebecca Greenberg, Animal Programs Director

Cover Photo Credits:

Gary Florin

Illustrations:

Celeste Schaadt

Disclaimer: This manual presents a compilation of knowledge provided by recognized animal experts based on the current science, practice, and technology of animal management at the time of publication. The manual assembles basic requirements, best practices, and animal care recommendations to maximize capacity for excellence in animal care and welfare. The manual should be considered a work in progress, since practices continue to evolve through advances in scientific knowledge. The use of information within this manual should be in accordance with all local, state, and federal laws and regulations concerning the care of animals. While some government laws and regulations may be referenced in this manual, these are not all-inclusive nor is this manual intended to serve as an evaluation tool for those agencies. The recommendations included are not meant to be exclusive management approaches, diets, medical treatments, or procedures, and may require adaptation to meet the specific needs of individual animals and particular circumstances in each institution. Commercial entities and media identified are not necessarily endorsed by AZA. The statements presented throughout the body of the manual do not represent AZA standards of care unless specifically identified as such in clearly marked sidebar boxes.

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Introduction

Preamble

AZA accreditation standards, relevant to the topics discussed in this manual, are highlighted in boxes such as this throughout the document (Appendix A).

AZA accreditation standards are continuously being raised or added. Staff from AZA-accredited institutions are required to know and comply with all AZA accreditation standards, including those most recently listed on the AZA website (http://www.aza.org), which might not be included in this manual.

Taxonomic Classification

Table 1. Taxonomic classification for "jellyfishes"

Classification	Taxonomy	Additional information
Kingdom	Animalia	
Phyla	Cnidaria Ctenophora	While taxonomists often disagree on whether medusae (Cnidarians) and comb jellies (Ctenohores) should be grouped together as "jellyfishes" we use the term for both due to similarities in their lifestyle and care.
Classes	Various	
Orders	Various	
Suborders	Various	
Families	Various	
	Various	

Genus, Species, and Status

Table 2. Phylum, species, and status information for "jellyfishes"

Phylum	Species	Common Name	USA Status	IUCN Status
Cnidaria	Various	Various	Not specified	None
Ctenophora	Various	Various	Not specified	None

General Information

The information contained within this Animal Care Manual (ACM) provides a compilation of animal care and management knowledge that has been gained from recognized species experts, including AZA Taxon Advisory Groups (TAGs), Species Survival Plan® Programs (SSPs), biologists, veterinarians, nutritionists, reproduction physiologists, behaviorists and researchers (visit the AZA Animal Program page to contact these individuals). It is based on the most current science, practices, and technologies used in animal care and management, and is a valuable resource that enhances animal welfare by providing information about the basic requirements needed and best practices known for caring for *ex situ* jellyfish populations (*hereafter referring to groups of both Cnidarian medusae and Ctenophores). This ACM is considered a living document that is updated as new information becomes available and at a minimum of every five years.

Information presented is intended solely for the education and training of zoo and aquarium personnel at AZA-accredited institutions. Recommendations included in the ACM are not exclusive management approaches, diets, medical treatments, or procedures, and may require adaptation to meet the specific needs of individual animals and particular circumstances in each institution. Statements presented throughout the body of the manuals do not represent specific AZA accreditation standards of care unless specifically identified as such in clearly marked sidebar boxes. AZA-accredited institutions which care for jellyfishes must comply with all relevant local, state/provincial, and federal wildlife laws and/or regulations; AZA accreditation standards that are more stringent than these laws and/or regulations must be met (AZA Accreditation Standard 1.1.1).

AZA Accreditation Standard

(1.1.1) The institution must comply with all relevant local, state/provincial, and federal wildlife laws and/or regulations. It is understood that, in some cases, AZA accreditation standards are more stringent than existing laws and/or regulations. In these cases the AZA standard must be met.

The ultimate goal of this ACM is to facilitate excellent jellyfish management and care, which will ensure superior jellyfish welfare at AZA-accredited institutions. Ultimately, success in our jellyfish management and care will allow AZA-accredited institutions to contribute to jellyfish conservation, and ensure that jellyfishes are in our future for generations to come.

Basic Taxonomy: The higher-level phylogeny of commonly maintained gelatinous zooplankton, specifically the Cnidarian medusae and Ctenophores covered by this manual, was adapted from works of Cairns et al. (2002), Cornelius (1997), and Wrobel & Mills (1998). We have added some of the commonly kept genera for each taxonomic group to help you recognize the groupings. The array of diversity of gelatinous plankton is astounding with a myriad of sizes, shapes, and colors enough to make Dr. Seuss feel right at home.

Gelatinous zooplankton is a broad term used to describe a group of actively swimming and drifting organisms, which also includes some mollusks and chordates, as well as the groups we have lumped as "jellyfishes." Their tissues consist of 95% or more of water. The tissue is soft, gelatinous-like, and easily damaged when handled. Jellyfish bells are typically used for propulsion and most species (excluding ctenophores) have stinging cells to assist in prey capture.

Table 3. Physical description of the species within the phylum Cnidaria

Class	Order	Description
Hydrozoa	Anthomedusae (Anthoathecata)	Jellies with a bell typically as tall or taller than wide. The gonads are located on the stomach or manubrium. All form a hydroid stage that is not enclosed in a cup (e.g., *Polyorchis, Sarsia*).
	Limnomedusae	Jellies that are usually dome shaped with gonads either on the stomach or on the radial canals. All form a hydroid stage that is not enclosed in a cup (e.g., *Craspedacusta, Maeotias, Olindias*).
	Leptomedusae (Leptothecata)	Jellies that usually have a bell as wide or wider than tall. Gonads are located on the radial canals. They typically form colony hydroids and have a well-developed cup that produces medusae (e.g., *Aequorea, Clytia, Eutonina, Tima*).
	Siphonophorae	Polymorphic jellies that may have well developed chain-like appearance or floats (e.g., *Physalia*).
Cubozoa		Jellies with marginal tentacles consisting of four, or in four groups of 2–15+ (e.g., *Chironex, Carybdea, Tripedalia*).
Scyphozoa	Rhizostomeae	Jellies lacking marginal tentacles and mouth arms fused somewhere along their length, bearing mouth-like openings (e.g., *Mastigias, Catostylus, Cassiopea, Stomolophus*).
	Semaeostomeae	Jellies with tentacles around the margin of the bell. More than four tentacles present and with well-developed mouth arms (e.g., *Aurelia, Chrysaora, Cyanea, Pelagia, Sanderia*).

Table 4. Physical description of the species within the phylum Ctenophora (comb jellies).

Class	Order	Description
Tentaculata	Cydippida	Pelagic; globular or ovoid body, with long retractable tentacles arising from sheaths (e.g., *Pleurobrachia, Hormiphora*).
	Lobata	Pelagic; body compressed with a pair of oral lobes; tentacles generally small (e.g., *Bolinopsis, Leucothea, Mnemiopsis*).
Nuda	Beroida	Pelagic; body cylindrical, thimble shaped or compressed; tentacles and sheaths absent (e.g., *Beroe*).

Species Identification Using General Morphology: The basic genera of jellyfishes can usually be reliably identified. However, species identification can be problematic due to very brief descriptions and a general lack of worldwide material to examine. As pointed out in Gershwin & Collins (2002), there is a general lack of standardization of morphological characters and many species are insufficiently described. This has caused great difficulty identifying a species from a poorly described species and resulted in a common practice of placing species as having a worldwide or widespread distribution over ocean basins. Using general morphological characters to identify species can cause confusion because not all members of a genus are typically examined to ensure that the described characters are diagnostic. As an example, *Cassiopea medusa* was described from Culion Bay, Philippines as being a distinct species based on a single specimen found in a group of *Cassiopea polypoides* (Light, 1914). This demonstrates that it is extremely important to examine the population's variations in characters before creating additional species. In Hawaii, Holland et al. (2004) found large variation in color and basic morphology within a population of Cassiopea, but only one species is present. To further confound species identification, descriptions are often incomplete and type specimens are often in very poor shape. New species are commonly described from isolated remote geographic locations or from unusual color morph specimens. This makes it difficult to get additional specimens from the original description site to compare with a current specimen (Dawson & Jacobs, 2001). Polymorphism continues to be a problem (Bolton & Graham, 2004).

Redescriptions of species may also cause some confusion. Gershwin & Collins (2002) reexamined a commonly accepted species *Pelagia colorata* and found morphological characters that were better suited to the genus *Chrysaora*. In addition, work by Freya Sommer at Monterey Bay Aquarium found this species had a scyphistoma stage that is also more indicative of *Chrysaora* than *Pelagia* (Sommer, 1988). The combination of morphological and life history studies is essential to place species in correct taxonomic groups. However, using morphological characters alone may not provide true taxonomic relationships.

Species Identification Using Molecular Genetics: When inspected carefully there are many cryptic species within a genus. Using *Aurelia* as an example, what seemed to be a worldwide species, *Aurelia aurita* rapidly became a cryptic species complex containing at least nine species (Dawson & Jacobs, 2001; Dawson et al., 2005). The molecular differences in *Aurelia* species complex revealed strong reproductive isolation. Combining genetic sequencing and geographic location information provides a clearer picture for species identification. Using this technique and then applying morphological comparison even cryptic species can be separated (Dawson, 2003). Molecular data can therefore assist in the evaluation of a given morphological character(s) (Knowlton, 2000).

Species identification can also be used to define the geographic origin of an introduced or invasive species. The genus *Cassiopea* was not reported in Hawaii during a 1902 survey and was first documented between 1941 and 1945 (Doty, 1961). It was thought that military boat traffic transported the species to Hawaii. In Hawaii, using general gross morphology *Cassiopea* were examined and found to be highly polymorphic within a given location (Holland et al., 2004). Based on the high degree of polymorphism a single species was assigned *Cassiopea andromeda*. Molecular investigation revealed two cryptic species being present that were 20.3% genetically divergent, and also showed evidence that *C. xamachana* was nearly genetically identical to *C. andromeda* from the Red Sea[1] (Holland et al., 2004). In this case two introduced species entered Hawaii from two different ocean basins, one from Indo-Pacific and one from the western Atlantic/Red Sea. This demonstrates that genetics not only provides species identity but also provides information on the species' original distribution in the case of an invasive species.

List of Jellies Exhibited in Public Aquariums and Zoos: The following list of jellies currently or previously on exhibit is from public aquarium and zoo professionals who are on the Jelly Directory kept by Mike Schaadt at Cabrillo Marine Aquarium. Note: the spelling of scientific names is based upon:
Kramp, P.L. (1952). Synopsis of the medusae of the world. *Journal of Marine Biology Association of the U.K.*, *40*, 1–469.

[1] Studies by Holland et al. (2004) and Arai et al. (2017) suggest that *C. xamachana* is *C. andromeda* introduced from the Red Sea. The World Register of Marine Species also recently updated its database to indicate that *C. xamachana* is no longer an accepted species name, and should be accepted as *C. andromeda*.

Table 5. Species exhibited in zoos and aquariums found within the phylum Cnidaria

Class	Subclass	Order	Species	Common Name
Hydrozoa		Anthomedusae	*Bougainvillia* sp.	
			Halimedusa typus	
			Leuckartiara sp.	
			Polyorchis penicillatus	Mudflat jelly
			P. haplus	
			Sarsia sp.	
			Spirocodon saltator	
			Turritopsis nutricula	
		Leptomedusae	*Aequorea victoria*	Crystal jelly
			Clytia gregaria	
			Eirene viridula	
			Eucheilota sp.	
			Eutonina indicans	Bell jelly/Umbrella jelly
			Mitrocoma cellularia	Cross jelly
			Tima formosa	
		Limnomedusae	*Craspedacusta sowerbii*	Freshwater jelly
			Maeotias inexpectata	
			Olindias formosus	Flower-hat jelly
	Siphonophorae		*Physalia physalis*	Portuguese Man ‘o War
Cubozoa			*Carukia barnesi*	Box jelly
			Carybdea alata	Box jelly
			C. marsupialis	Box jelly
			Chironex fleckeri	Sea wasp
			Tripedalia cystophora	Box jelly
Scyphozoa		Rhizostomeae	*Cassiopea andromeda* (formerly *C. xamachana)*	Upside-down jelly
			C. frondosa	Upside-down jelly
			Catostylus mosaicus	Blue Blubber jelly
			Cephea cephea	Crowned jelly
			Cotylorhiza tuberculata	Mediterranean jelly
			Netrostoma setouchianum	Crowned jelly
			Phyllorhiza punctata	White-spotted jelly
			Pseudorhiza haeckeli	
			Rhizostoma pulmo	Barrel jellyfish
			Stomolophus meleagris	Cannonball jelly
		Semaeostomeae	*Aurelia aurita*	Cold water moon jelly
			A. labiata	Warm water moon jelly
			Chrysaora fuscescens	West coast sea nettle
			C. chesapeakei	Atlantic bay sea nettle
			C. quinquecirrha	East coast sea nettle
			C. colorata	Purple-striped jelly
			C. melanaster	Northern sea nettle
			C. pacifica	Japanese sea nettle
			C. plocamia	South American sea nettle
			C. achlyos	Black sea nettle
			Cyanea capillata	Lion’s mane jelly
			C. lamarkii	Bluefire jelly
			Drymonema dalmatinum	Pink meanie
			Pelagia noctiluca	Mauve stinger
			Phacellophora camtschatica	Egg yolk jelly
			Sanderia malayensis	Amakusa jelly

Table 6. Species exhibited in zoos and aquariums found within the phylum Ctenophora (comb jellies).

Class	Order	Species	Common name
Tentaculata	Cydippida	*Hormiphora* *Pleurobrachia bachei*	Sea gooseberry
	Lobata	*Bolinopsis mikado* *B. infundibulum* *Leucothea pulchra* *Mnemiopsis leidyi* *M. mccradyi*	Sea walnut
Nuda	Beroida	*Beroe cucumis* *B. forskalii* *B. ovata*	

Nomenclature: Jellyfish, Sea Jellies or Gelatinous Zooplankton? Individual aquariums and zoos differ in their terminology when referring to jellyfishes that they display to their visitors. Some call them sea jellies while others stick to the traditional common name of jellyfish. Those that insist that sea jellies are a more precise name make the point that jellyfishes are not fish. It is the prerogative of the individual aquarium or zoo to choose the common name that best suits their educational mission. Also, since this care manual includes ctenophores, which are not even in the same phylum as Cnidarian medusae, a more scientifically precise name for the group of "jellyfishes" covered in this manual might be "gelatinous zooplankton." However, this multi-phyletic group also includes many other organisms like pteropod and heteropod mollusks and salps (chordates). In order to minimize confusion, we will use "medusae" to describe jellyfishes belonging to the phylum Cnidaria. Ctenophora will simply be referred to as Ctenophores or comb jellies. When we include members of the phyla Mollusca and Chordata, along with Cnidaria and Ctenophora, we will use the term "gelatinous zooplankton."

Cnidaria: Most common cnidarian jellies, and almost all that are displayed by public aquariums, exhibit two morphologic stages. The pelagic medusa stage is most familiar. The sessile polyp stage is inconspicuous, but it is this life stage that makes possible and practical the culture and propagation of jellies for aquarium exhibits.

The sessile stage is typically small (1–2 mm tall) and usually colonial. There is no sexual reproduction in this stage. Sessile polyps can spread asexually to generate other polyps—or they can give rise to the pelagic (medusa) stage by another asexual process called strobilation. The medusae are free-swimming and solitary. Most medusae become conspicuously large, although some hydrozoan species (Hydromedusae) can be quite small (1–2 mm). With few exceptions, jellies are dioecious—each medusa is either male or female. In most cases, the medusa stage can only reproduce sexually, and in most species the fertilized egg eventually gives rise to a new sessile polyp. An exception to this, for example, would be *Aequorea* sp. with medusae that can asexually reproduce through fission. There are species in which the fertilized egg develops directly into another medusa, either exclusively (*Pelagia noctiluca*) or rarely (*Aurelia aurita*) (Arai, 1997).

Medusoid Stage (see Chapter 8, Figure 4 for illustration)
(Hydromedusa and Scyphomedusa—orders Anthomedusae, Leptomedusae, Semaeostomeae, and Rhizostomeae): Most medusae are reminiscent of a bell or an umbrella shaped structure. The convex top of the bell is referred to as the *exumbrella* and is the aboral side, as it is away from the mouth. The concave underside of the bell is known as the *subumbrella* and is the oral side, where the mouth is centrally located. The bell consists primarily of *mesoglea* (a jelly-like matrix with or without cells), muscle and nerve fibers, and the subumbrella, which serves as an attachment site for digestive and reproductive structures. The bell plays an important role in locomotion and generally represents a high percentage of the total volume of the animal (Arai, 1997). A *velum* is a thin muscular tissue arising from the inner margin of the bell, and is present in hydrozoans only, acting as a key distinguishing feature of the two classes (Wrobel & Mills, 1998). Cubozoans have an analogous (but not homologous) structure called a velarium (Brusca & Brusca, 1990).

Additional structures can be found at the margins of the bell. Tentacles (marginal, stinging, or fishing) are present (except in Rhizostomeae). The tentacles serve primarily in prey capture and defense. Generally, they house the highest proportions of stinging cells (i.e., cnidocytes or nematocysts) utilizing a variety of toxins (Lotan et al., 1995). The stinging cells fire upon mechanical stimulus of the trigger cnidocil, or from a variety of chemical cues (Burnett & Clayton, 1986; Brusca, 1990; Arai, 1997). Rhopalia (marginal sense organs) occur at regular intervals along the margin of the bell. The rhopalia house concentrated

levels of sensory receptors. They are complex structures that can show sensitivities to light, gravity, touch, and chemicals (Arai, 1997). Intervals along the margin between rhopalia are known as lappets.

Scyphozoan medusae capture food by using the marginal tentacles and oral arms, the large frilly tissues originating from the mouth on the oral side of the bell. Once captured, food is transferred to stomach pouches (typically four are present). In some species, digestion begins within the oral arms, but the bulk of the process occurs in the stomach pouches (Arai, 1997).

Hydrozoans lack oral arms and separate stomach pouches. Instead, the mouth is located at the end of an often highly maneuverable structure called a manubrium, which functions as a gastric cavity. It remains very active during feeding, picking off captured prey items from the marginal tentacles. Scyphozoans in the order Rhizostomeae also have manubria. Many scyphozoans and hydrozoans also have radial canals associated with the gastrovascular system and some have an attached marginal ring canal. Gonads are present in mature specimens. Gonad tissues arise from gastrodermis in scyphozoans. They are usually located on the floor of the gastrovascular cavity, peripheral to the gastric cirri (Arai, 1997). Gonad tissues in hydrozoans are either adjacent to the manubrium or associated with the radial canals. Most scyphozoans and hydrozoans are dioecious (separate sexes).

Polypoid Stage (see Chapter 8, Figure 2 for illustration).
(Hydromedusa—orders Anthomedusae, Leptomedusae): Hydrozoan polyps, or hydroids, attach to a substratum. The anchoring structure is termed a *hydrorhiza*.

The stem or stalk-like structure is termed a *hydrocaulus*. From the hydrocaulus, several types of polyps can occur, including *hydranths* or *gastrozooids* (for feeding), gonozooids (for reproduction), and *dactylozooids* (for defense). Dactylozooids are heavily armed with cnidae and often surround gastrozooids as protection and to assist in food capture (Brusca & Brusca, 1990). According to Brusca, the gonozooids form medusa buds called gonophores that can either be retained or released.

(Scyphomedusa—orders Semaeostomeae, Rhizostomeae): Scyphozoan polyps, *scyphistomae*, generally resemble their cousins, the sea anemones, from the class Anthozoa. They attach to suitable substrate with a base called a *pedal disc*. The polyp extends out from the substrate, forming a stalk that concludes with a *calyx*. The calyx includes an oral disc with a central mouth and a ring of up to 24 tentacles (Arai, 1997). The stalk can be cylindrical, as in most *Chrysaora* spp., or fluted as in many rhizostomes. Runners known as *stolons* may be present that extend longitudinally from the stalk to give rise to new polyps or aid in movement. Scyphistomae of some species produce podocysts, from which new scyphistomae emerge. In such cases, the parent polyp encapsulates material in chitin that remains dormant until triggered to "bloom" into an entirely new polyp

Ctenophora: Ctenophores, commonly known as comb jellies, have clear, gelatinous bodies characterized by having eight rows of ciliated plates (comb rows) radiating from aboral to oral surfaces that they use for locomotion. They are the largest animal to use cilia for locomotion. Their bodies are round, oblong, or even compressed with two lobes.

Lobate ctenophore: Lobate ctenophores have small tentacles and compressed bodies with two large lobes at the oral end (e.g., *Mnemiopsis*, *Bolinopsis*).

Cydippid ctenophore: Cydippid ctenophores are solid spherical or ovoid bodies with a pair of long retractable tentacles arising within sheaths on opposite sides of the body. Tentacles have smaller branches called *tentilla*. The mouth is on one end. Prey are captured on the tentilla by the sticky cells called *colloblasts,* and eventually transferred to the mouth as the ctenophore tumbles through the water. The tumbling is called "Veronica's Display" since it resembles a matador swishing his cape in a bullring (e.g., *Pleurobrachia*, *Hormiphora*).

Beroid ctenophore: *Beroe* ctenophores are oblong in shape and laterally flattened. There are no tentacles. The large mouth is on one end. Prey is exclusively tentaculate ctenophores (e.g., *Pleurobrachia*).

Jellyfish Terminology

- Balling: A pathological process where the bell of a jelly contracts into a tight sphere with an unusually small opening. This may be caused by trauma or improperly adjusted water flow.
- Bell: The umbrella shaped body of jellies.
- Colloblasts: Adhesive cells found only on the tentacles and tentilla of ctenophores.

- Cnidaria: Phylum that contains simple organisms (diploblastic radiates) that possess cnidae (stinging cells) situated around a central mouth.
- Ctenophora: Phylum that contains simple organisms possessing colloblasts and comb rows. Also known as comb jellies or sea gooseberries.
- Cubozoa: A class of Cnidaria where the jellies' bells are roughly box-shaped.
- Dactylozooids: A specialized polyp in a hydroid colony that provides defense for the colony.
- Dioecious: Each medusa has either male or female sex organs (also known as gonochoristic).
- Ephyra: Small, first stage, free-swimming jelly destined to grow up to mature and become the adult medusa.
- Eversion: The pathological process where a jelly appears to turn "inside-out" with the bell outer surface becoming convex.
- Exumbrellar: The aboral surface of the bell of a jelly.
- Gastrozooids: A specialized feeding polyp in a hydroid colony that shares its food with the rest of the colony (also known as a hydranth)
- Gonozooids: The medusa-producing polyp in a hydroid colony (also known as gonangium).
- Hartford loop: A system of piping that acts as a safety device to prevent water from draining out of an aquarium if a leak develops in the return piping. Also establishes a minimum water level in freestanding cylinders or other remote tanks that have outlflow pipes below water level but no overflow box.
- Hydrocaulus: Branched upright stem of a hydroid colony.
- Hydromedusae: A medusa of the class hydrozoa. Differentiated by the possession of a velum on the rim of the bell. The velum is important in locomotion. Medusae belonging to the class Hydrozoa.
- Hydrorhiza: Root-like structure of a hydroid colony.
- Hydrozoa: A class of Cnidaria in which most members have polyps arranged in colonies that is made up of different polyps with different functions.
- Laminar Flow: "when a fluid flows in parallel layers, with no disruption between the layers. At low velocities, the fluid tends to flow without lateral mixing, and adjacent layers slide past one another like playing cards. There are no cross-currents perpendicular to the direction of flow, nor eddies or swirls of fluids." (Wikipedia)
- Manubrium: An extension of the mouth in jellies that often is the place where the oral arms originate.
- Medusa: The planktonic stage of most jellies, which is responsible for sexual reproduction.
- Mesoglea: Translucent jelly-like substance found between the two epithelial cell layers in the bodies of cnidarians. Mesoglea makes up the bell of a jelly and is mostly water. In scyphozoa there are living cells that can move throughout the mesoglea. There are no living cells in the mesoglea of hydrozoans.
- Monoecious: Jellies that contain both male and female sex organs in the same individual.
- Nematocysts/cnidocysts/cnidae/stinging cells: Specialized cells that when mechanically stimulated shoot a tiny harpoon-like dart into the tissue of prey or predators.
- Ocelli: Light sensing organs embedded within the rhopalia.
- Oral arms: Extension of the manubrium (mouth) in jellies.
- Phytoplankton: Plants (mostly unicellular) at the mercy of ocean currents.
- Planktonkreisel: A name coined by the German scientist W. Greve in the 1960s, and further refined by Bill Hamner of UCLA in the 1990s, to describe a type of aquarium with gentle circular currents designed to simulate a water column for planktonic organisms. Many adaptations to the original design have resulted in pseudokreisels (those without laminar flow for water entering) and stretch kreisels (those wider than tall and usually with two gentle circular currents).
- Planula larva: What the fertilized egg metamorphoses into. Cnidarian larval form.

- Podocysts: A tiny round, flat structure that some scyphozoan polyps grow at their base. They are capable of growing into a polyp when the conditions are right. Podocysts can remain dormant for months and even years.
- Polyp: The common name for the asexual sessile stage of hydrozoan, scyphozoan and cubozoan.
- Rhopalia: Found embedded in the lappets of the ephyrae and in the rim of the bell in adult medusa. Contains sense organs (including ocelli for light reception and statocyst for gravity reception).
- Scyphistoma: The scientific name of the polyp stage of most jellies.
- Scyphomedusae: A medusa of the class schyphozoa. Scyphomedusae tend to be much larger than hydrozoan medusae and lack a velum at the rim of the bell.
- Scyphozoa: A class of cnidaria in which the polyps tend to be solitary, medusae tend to have mouth arms and gonads arranged in a cloverleaf pattern just under the bell.
- Statocyst: Gravity sensing organ embedded within the rhoplia.
- Strobilation: A form of asexual reproduction found in the scyphozoa beginning with segmentation of the polyp and ending with an ephyra.
- Subumbrellar: The oral surface of the bell of a jelly.
- Tentilla: Short extensions arising from the tentacles of ctenophores that have the adhesive cells (colloblasts) attached.
- Velarium: A ring of tissue that extends around the inner margin of the bell in cubozoan medusae. Aids with propulsion and maneuverability.
- Velum: A structure found in the hydrozoan jellies that looks much like a shelf attached to the rim of the bell.
- Zooplankton: Animals that are at the mercy of ocean currents. Most have the ability to move on their own in a small space but are swept along with ocean currents.
- Zooxanthellae: Symbiotic, single-cell algae that live within the tissues of some jellies. Where present, they are biologically important and the host must be provided with bright, natural lighting.
- Zooxanthellate: An animal that harbors symbiotic zooxanthellae in its tissues.

Chapter 1. Ambient Environment

1.1 Temperature and Humidity

> **AZA Accreditation Standard**
>
> **(1.5.7)** The animals must be protected or provided accommodation from weather or other conditions clearly known to be

The animals must be protected or provided accommodation from weather, and any adverse conditions. (AZA Accreditation Standard 1.5.7). Jellyfishes not normally exposed to warm temperatures should be provided chilled water. Likewise, protection from excessive cold temperatures should be provided to those animals normally living in warmer water.

As different systems are discussed in this chapter some of the important variables associated with raising jellyfishes will be briefly addressed. Not every species or every water quality issue can be covered. This chapter is intended to help an experienced fish aquarist understand some of the unique problems encountered when a jellyfish display is set up.

Variation in species and display requirements allow for a huge range of acceptable temperatures to be used. Widmer (2008) gives 12° - 21° C (54° - 69.8° F) as the fastest growth rate for *Aurelia aurita* ephyrae. This temperature may be required to raise enough moon jellies for a large exhibit or as food for other jellies. Lower temperatures generally result in healthier adult jellies that can live for a much longer time. For *Aurelia labiata*, 13° - 16° C (55.4° - 60.8° F) will allow the medusae to thrive within enclosures for up to several years with much fewer deformities due to heat stress or rapid growth. Temperatures for temperate water jellies can run from 10° - 20° C (50° - 68° F) with some species being able to tolerate an even larger range, but given the delicate nature of jellies, cooler water generally yields better results. Tropical jellies, on the other hand, tend to have more trouble dealing with water that is too cold rather than water that is too warm. Many tropical species (e.g., *Mastigias*, *Catostylus*) do well between 22° - 28° C (71.6° - 82.4° F). Cold water jellies (e.g., *Chrysaora colorata*, *Phacellophora camtschatica*) are normally much harder to keep because most are medusivorous (the need to eat other jellies), and chillers are required. They are not recommended for anyone trying jelly husbandry for the first time.

AZA institutions with exhibits which rely on climate control must have critical life-support systems for the animal collection and emergency backup systems available, while all mechanical equipment should be included in a documented preventative maintenance program. Special equipment should be maintained under a maintenance agreement or records should indicate that staff members are trained to conduct specified maintenance (AZA Accreditation Standard 10.2.1).

For any jellies that will be kept below normal comfortable ambient room temperatures for humans (around 21° C, or 70° F), a chiller is required. For tropical jellies, a heater may be required to reliably keep the water within about 2° - 3° C (35.6° - 37.4° F) of the desired temperature. In both cases, electrical power is required and there should be a backup generator to make sure that chillers, heaters, and pumps can continue to maintain water temperature and water flow during a power outage. There should be an alarm system that notifies an experienced staff member to respond if temperature changes more than 2–3 degrees. Back-up chillers or heaters, if installed, should be set to a slightly higher (chillers) or lower (heaters) temperature than the primary temperature control device. This will allow them to switch on shortly after the primary unit fails.

AZA institutions with exhibits which rely on climate control must have critical life-support systems for the animal collection and emergency backup systems available. Warning mechanisms and backup systems must be tested periodically (AZA Accreditation Standard 10.2.1).

> **AZA Accreditation Standard**
>
> **(10.2.1)** Critical life-support systems for the animals, including but not limited to plumbing, heating, cooling, aeration, and filtration, must be equipped with a warning mechanism, and emergency backup systems must be available. Warning mechanisms and emergency backup systems must be tested periodically.

1.2 Light

Careful consideration should be given to the spectral, intensity, and duration of light needs for all animals in the care of AZA-accredited zoos and aquariums.

Lighting is an easy way to enhance a display's appearance and allow visitors a better view of an almost transparent animal. The choices for jelly lighting can include standard outdoor floodlights, track lights (both standard bulbs and high intensity), compact fluorescent, metal halide, fiber optic, or LED lights. Each of these options has pros and cons. The choice can be based more on costs and aesthetic preference and

less on biology, except in the cases of tropical jellies that harbor commensal, photosynthetic zooxanthellae in their tissues, or perhaps for deep sea gelatinous forms.

Standard white lighting is fine for moon jellies or darker jellies, but experimenting with colored lights and gels should result in the right choice for each application. Blue lighting on moon jellies gives people more of a feeling of being out in the ocean with them. Red light gives an ominous appearance. With animals like ctenophores, narrow-beam intense lights show off the comb rows. Pinpoint light sources (such as quartz halogen MR16 lamps or LED lights) enhance the appearance of internal structures via the creation of shadows. Broad sources such as fluorescent tubes negate this effect. If the tank is long and narrow, changing from one color lighting to another may be an option. Using a creative or imaginative approach to lighting jellies often visually enhances their display.

When the façade of a jellyfish exhibit does not hide the side walls or bottom completely, lighting can also be helpful in diverting visitors' lines of sight from the screens, walls, and tops of tanks so that a visitor's attention is drawn and remains on the jellies. This can be done with spotlights, "mail slots," and "barn doors" that redirect light. Some institutions choose to hide the walls and floors of the exhibit so as to enhance the look of an open ocean column of water. This results in the loss of a viewing area along each window edge that is roughly equivalent to the front-to-back width of the display. These geometry and refraction issues often result in a larger tank with a significantly smaller viewing area. For example, a 10 ft (3.048 meter2) wide exhibit with a 2 ft (0.61 meter) front-to-back dimension will only provide a ~6 ft (~1.83 meter) wide viewing window if all sides and bottoms are hidden.

Some institutions may choose to not hide the walls and floor of the tank from visitors' view to allow a larger viewing area. Cost and floor loading issues may make a smaller tank with a bigger window necessary. Each institution needs to consider their aesthetic and operational priorities and choose what works best for them and the jelly inhabitants. Exposing the technology of the tank may also provide an opportunity to educate visitors about jelly husbandry. In fact, windows into "Jelly Labs" are often included in large jelly galleries, allowing visitors to look "behind the scenes" and see all aspects of the life support system (LSS), tank structure, and culture operation.

When jellies harbor zooxanthellae in their tissues, lighting becomes a husbandry issue. Even though these jellies may be circulating in a tank, their requirements are similar to a sedentary coral. The spectrum of light used should contain significant amounts of light in the wavelengths between 400–500 µm. A photoperiod between 10–14 hours is also important. If mixed lighting is used (multiple sources of different intensities), the most intense lamps should be on for a shorter duration toward the middle of the photoperiod (similar to lighting for corals). Generally speaking, a mix of daylight bulbs in the 5,000–6,500° K color temperature range, and at least one in the blue range of 10,000–20,000° K, will keep the zooxanthellae happy and the jellies healthy while giving the tank an attractive hue. Staff working with zooxanthellae jellies should have an understanding of basic photobiology and lighting tech, including the action spectrum of zooxanthellae photosynthetic pigments (Chlorophyll C, Peridinin and other xanthophylls), color temperature, color rendering index (CRI), photosynthetically active radiation (PAR) and the useful spectra of lighting. This information can be easily found in popular books on live coral husbandry.

Although tropical jellies can deal with very warm waters, strong lighting can rapidly heat up water further to dangerous levels especially in small volume closed systems. Testing the lights before you put jellies in the tank will help keepers gauge how much heat is added to the tank, and whether the addition of a chiller is warranted. Remember to turn off any high intensity lights to prevent overheating the jellies if the water circulation system is stopped for more than 15 minutes.

1.3 Water and Air Quality

AZA accredited institutions must have a regular program of monitoring water quality for aquatic animals, and a written record must document long-term water quality results and chemical additions (AZA Accreditation Standard 1.5.9). Monitoring selected water quality parameters provides confirmation of the correct operation of filtration, as well as the disinfection and purification of the water supply available for the collection. Additionally, high quality water enhances animal health programs instituted for aquatic collections.

AZA Accreditation Standard

(1.5.9) The institution must have a regular program of monitoring water quality for fish, marine mammals, and other aquatic animals. A written record must be maintained to document long-term water quality results and chemical additions.

Water Flow: Jellies' needs vary from most fishes partly because they are plankton and therefore dependent upon water movement for survival. Flow is of utmost importance with most species of jellies, so specially designed tanks and flow regimes are required to house them. Without enough flow, the jellies may get pulled into the drain screens or settle to the bottom. The soft body of a jelly might be torn (or crushed against a wall) if a pump sprays directly on a jelly. To prevent this from happening, create a flow pattern that spreads the moving water into a thin ribbon of uniform direction and velocity along an entire wall of the tank. This "laminar flow" can be accomplished by using a spray bar or slots with strategically spaced openings across the full width of the tank wall where the flow originates. By directing this laminar flow over the entire width of a drain screen, jellies are pushed away from the screen while a directional current is created. Benthic (e.g., *Cassiopea* spp, etc.) or semi-benthic (e.g., *Polyorchis* spp, *Olindias* spp., etc.) jellyfish species can be housed in conventional tanks, but incoming water flow should enter the tank in such a way as to push animals away from the drain screen. Drain screens should also be wider than any individual jelly, so as to minimize the chances of an animal becoming entirely suctioned to it as it passes by.

Flow requirements will vary with tank design and size as well as per species and life history stage, but it should always be such that it gently moves the jelly along with the flow but does not spin the jelly. Both bell eversion and balling can result from an improper flow rate. Malnutrition can also occur when the flow rate is sub-optimal. The jellies are unable to feed properly when the flow is too strong or too weak. Learning to judge and properly set flow requires finesse and patience. It is one of the more challenging jelly husbandry skills to master, particularly because it can vary from species to species and between life history stages for each species. If the same aquarium is used for a different species of jelly, the whole process must begin again. For example, a lion's mane jelly trailing a foot of oral arms and three feet of tentacles, will need different flow rates than a less elaborate moon jelly. It is best to introduce jellies into a new system with minimal flow and then incrementally turn the flow up as needed to give the particular species you are working with its adequate flow rate. It is crucial to allow time for the system and flow regime to fully equalize within the enclosure before reassessing the need for further adjustments. The time between adjustments can be an hour or more. When setting flow rates, patience is key and in general, one's flow mantra should be, 'how low can you go' so that the jellies remain within the public viewing area without being pushed excessively throughout the enclosure. Where possible, observation of wild specimens or others' exhibits will assist in learning what is adequate. Different size jellies of the same species will also require different flow rates. This is one reason to keep similar size jellies together both on exhibit and in the off-exhibit holding area.

Open Systems versus Closed Systems: When discussing life support systems, aquariums define "open systems" as systems in which water is replaced continually with new water from a natural water body. Open systems normally provide seawater with adequate levels of required nutrients, but incoming raw seawater may contain pest species and chemical contaminants. Therefore, some level of mechanical and chemical filtration should be considered and may be required. Closed systems can be defined as aquariums that recycle water and receive a limited supply of new water as needed. No true "closed system" exists in a zoological environment since water will always need to be replaced due to evaporation or exchanged to maintain water quality. Both open and closed systems can be used for jellies, but both require an understanding of each system's benefits and limitations.

Open systems provide many advantages when water quality normally is consistent over time, but one should be aware of possible problems that can arise from the use of natural seawater. When adding new water to a system, it is important to match temperature, salinity and dissolved oxygen levels as closely as possible. Routing incoming new water into and through a large volume reservoir sump ensures adequate mixing and an opportunity to adjust these parameters prior to delivery to enclosures and effectively reduces potential hazards to jellyfish well-being. Jellies can handle small, slow changes in salinity and temperature, but because the density in the jelly depends on temperature and salinity of the water to which they are exposed, rapid changes can cause buoyancy problems observations of which, if not properly diagnosed as such may lead to improper and potentially harmful adjustments to flow regime. It is best if the temperature and salinity of the area in which each species originates is replicated as closely as possible.

When drawing raw seawater from the ocean, animals such as hydroids, copepods or amphipods may be introduced. Also, wild caught jellies sometimes harbor these creatures which adds to the challenge of maintaining a system free of these fouling animals. The use of semi-open systems, where natural water is pulsed through the system regularly only when parameters are optimal, provides opportunities to buffer

animal populations from both pests and water quality variations. This is a typical strategy at seaside facilities.

Most aquarists can attest to how hard removing pest hydroids can be. Filtration and UV sterilization can be utilized to keep these unwanted colonists from getting out of control. Unfortunately, planulae can swim unharmed through a UV sterilizer, because the contact time is not long enough to kill them. Nothing is 100% effective, so temporarily removing exhibit specimens, draining exhibits and plumbing, and bleaching much of the system is the only way to control hydroid overgrowth. The frequency of bleaching varies significantly and is dependent on jelly species, filtration methods, water temperature, the diameter of gravity plumbing to sumps, the amount of food entering a system (hydroids eat what jellies eat), the ease of mechanically removing hydroids from exhibit tanks, etc. Some institutions do this monthly, while others can operate certain systems for a year or more before bleaching is needed.

Typical water quality considerations are focused on how water quality affects medusae, but parameters specific to polyps will be considered within this manual when issues arise that might affect them. Prior proficiency with the care of fishes, and their associated water quality requirements, is helpful when planning to maintain jelly systems. Most jellies commonly housed in public aquariums are hardy when it comes to most water quality issues, but one should be aware that things proven harmful in living coral tanks also affect jellies. If one adheres to common water quality parameter target ranges, generally excluding temperature, for such reef systems, the jellies housed in these conditions should thrive. Manipulation of some parameters are used to induce strobilation in the polyps, but would not be ideal for medusa of the same species. Unlike fish, jellies may tolerate relatively high levels of ammonia for short periods of time, but are quickly killed by very low levels of copper, zinc and other heavy metals. While copper levels are required to be reported on EPA Consumer Confidence Reports (CCR) for an aquarium's city, zinc is not, and the effects of copper and zinc together are more than additive. Zinc orthophosphate is commonly added to mitigate pipe corrosion. All public water supply departments can provide a detailed water report or tests can be done to confirm whether these contaminants are present. Pre-treating city water with both activated carbon and reverse osmosis may be necessary to bring metal levels to non-lethal levels and this has been confirmed by multiple facilities.

There are a number of parameters to consider. The following chart shows ideal conditions for some of the factors that affect the health of jelly systems. These are suggested values for a healthy stable system, not the maximum or minimum levels jellies can tolerate (which will vary species to species).

Table 7. Ideal water conditions for housing jellies

Ammonia (unionized)	<0.02 ppm
Nitrites	<0.02 ppm
Nitrates	10 ppm
Copper	<0.01 ppm
Salinity (most medusa)	32–35 ppt
pH	8.0–8.4
Dissolved Oxygen	75–99%

As noted above, jellies can have problems with metals that may be dissolved in the water. If at all possible, make sure copper levels are undetectable. When testing for copper, a colorimeter will give a high enough degree of accuracy where a test kit made for home aquariums might not read low enough levels to ensure safety. If you are utilizing a natural water source that either gets large amounts of seasonal runoff, or taking water from a lagoon that might be dredged periodically, suspending metals or pesticides in the water column, consider running the tanks as a closed system and pretesting all incoming new water. Carbon filters can be added to either open or closed systems, but carbon dust from granular material can be an issue in jelly tanks. If possible, always rinse new carbon filters with running tap water until the water runs clear of any carbon dust just prior to use. A filter pad that has carbon embedded into it is one possible way to help ensure no copper infiltrates the system and it reduces the possibility of added carbon dust. Carbon "block" filter cartridges intended for lower volume supplies avoid this. There are also other copper absorbers on the market, which seem to work well. Be aware that copper might not be the only thing present in the water and carbon is known to absorb many harmful items very effectively.

Closed systems require more maintenance in most cases, but allow the aquarist direct control over the water supply. Rapid changes stress almost all animals and jellies are no exception. When changing system water, matching the new water to the system's parameters will help reduce problems. Reverse osmosis or deionized (RO/DI) waters are best to use when making seawater for closed systems. It will be necessary

to pre filter the water entering an RO unit with carbon to remove chlorine or chloramines which can damage certain RO membranes, in addition to being toxic to marine life. Once the water is collected in a storage reservoir, aerate the make-up water for 24 hours prior to use for best results. The use of raw tap water to make seawater for jelly systems is not recommended. Although most dechlorinator solutions claim to be safe for invertebrates, some tend to cause pitting and eventual breakdown of the jelly's tissue.

When setting up a closed system for jellies most of the same rules used for fish systems apply. There are, however, notable exceptions. The most important ones to consider are water return (to the aquarium) and drain line designs. Unlike fish, jellies can't swim away from drains, so they have to be pushed away. This is where the concept of laminar flow is put to the test. Laminar flow should be designed to gently direct a broad flow of water across a large screen or perforated wall behind which the water drains. This effectively reduces suction created by water exiting the enclosure while gently pushing delicate, soft-bodied jellies away. Excessive suction can pull jellies into the screens causing severe damage to both the jellies and the screen system.

Return lines that normally provide flow to the aquarium should never contain bubbles, nor should air diffusers or any other agitation that creates bubbles be present in a jelly tank. Bubbles that become trapped in a jelly bell will work their way through it, causing serious damage and even death. Bubbles can also cause a jelly to float, which inhibits feeding. In some cases, floating jellies can also clog the screens or overflows. Return lines must be positioned below the surface and cleared of air before adding jellies. A well-designed system will take this into account so that when water changes occur, or if the power goes out, air won't flush into the tank and into the jellies. Low flow rates, standpipes, Hartford loops, and check valves can save the aquarist a world of headache. Almost every person who raises jellies has spent a few hours trying to remove air bubbles from the underside of a jelly's bell. It may seem easy to tip a jelly over to let the air float up and out, but it is not when one is dealing with hundreds of jellyfish or the jelly is an egg yolk jelly with long frilly oral arms and tentacles that stick to everything, including the aquarist. It is soon discovered that air loves mucus and "mild stings" are not so mild when the tentacles remain on a tool that an aquarist accidentally lets rest against the back of their arm. Before an institution ends up with floating jellies and a staff covered in arm rashes, make sure the system is prepared for a power outage or that water changes won't fill the enclosure(s) with bubbles.

Supersaturation is another potential source of micro-bubbles within a jelly system. Jellies can tolerate much lower oxygen levels, but if oxygen levels get too high and gases start diffusing out of the water and adhere to the enclosure walls, it is only a matter of time before bubbles become entrapped under a jelly's bell. Supersaturation is often caused when cool, fully-saturated water is added to a warmer system. Since warmer water can't hold as much dissolved gas, it is released in the water (and inside animals) as bubbles. Leaks on the suction side of water pumps will also suck air, which is then pressurized into solution by the impeller. Water flowing into a sump can also create bubbles and care should be taken to make sure these are not sucked into the intake manifold supplying the pump with water. The result is the same, the bubbles are pressurized in the pump. Once the pressure is removed (the water leaves the pump and enters your tank) the excess gas starts to work its way out of solution. Trickle towers or gravity feed systems placed inline before the water enters the display aquarium can help prevent this from becoming an issue.

1.4 Sound and Vibration

Consideration should be given to controlling sounds and vibrations that can be heard by animals in the care of AZA-accredited zoos and aquariums.

Jellyfish do not have auditory or vibration sense organs. While there is no known impact of vibration on jellies, excessive vibration in LSS should be avoided as this may indicate equipment is not functioning or mounted properly.

Chapter 2. Habitat Design and Containment

2.1 Space and Complexity

Careful consideration should be given to exhibit design so that all areas meet the physical, social, behavioral, and psychological needs of the species. Animals must be well cared for and presented in a manner reflecting modern zoological practices in exhibit design (AZA Accreditation Standard 1.5.1). All animals must be housed in safe enclosures that meet their physical and psychological needs, as well as their social needs. (AZA Accreditation Standards 1.5.2, 1.5.2.1, 1.5.2.2).

AZA Accreditation Standard

(1.5.1) All animals must be well cared for and presented in a manner reflecting modern zoological practices in exhibit design, balancing animals' welfare requirements with aesthetic and educational considerations.

AZA Accreditation Standard

(1.5.2.2) All animals should be provided the opportunity to choose among a variety of conditions within their environment.

AZA Accreditation Standard

(1.5.2.1) All animals must be kept in appropriate groupings which meet their social and welfare needs.

AZA Accreditation Standard

(1.5.2) All animals must be housed in enclosures which are safe for the animals and meet their physical and psychological needs.

Setting up the System: Jellyfish enclosures must be free of sharp corners or obstructing objects including substrate. The most common effective enclosure design for non-rhizostome jellies is a "kreisel" type. The name is derived from the German word describing a roundabout or spinning object. In their most basic configuration, these aquaria typically take the form of a short cylinder with the face of the disc oriented vertically. They will have a water return line providing laminar, rotational flow and some type of drain screen where water exits the tank. The simplest return is a spray bar that is aimed over the surface of the screen, pushing the jellies away from it. The size and exact shape of the tank will determine if this flow will be enough to keep your jellies happily moving in the water column, or whether additional spray bars are needed. Once the water leaves an enclosure, a Hartford loop can ensure the tank does not drain below the spray bar (if it is near the top). Elongated "stretch kreisels" are also common and can be used for the same species. They differ in that two opposing rotational flows are created at either end, resulting in an upward or downward flow at the center of the tank, depending on the design. Simpler "psuedokreisels" place all screens and return spray bars at the top of the aquarium, and are easier to maintain. A number of other designs can also be effective for particular species.

If the system is closed, this drain line should lead to a sump of some kind. Jelly tanks tend to have large amounts of excess food getting flushed out the drain. To help the system stay clean, a simple 200-micron filter bag should be placed on all sump returns. The design of these basic mechanical filtration components should be easily accessible and routinely replaced with cleaned, reusable bags. If the sump is designed with a trickle plate, simply tipping it slightly and covering the plate with a filter pad will work in place of a bag. The sump should be big enough to hold enough bio-media to handle normal wastes coming from the tank. Since almost all jelly tanks will get invasive hydroids, adding disconnect couplings and/or cleanout ports (as used in residential waste lines) throughout the piping system will save time when cleaning. Unions and true-union valves should also be installed at the inflow and outflow sides of each LSS component. This speeds servicing in case of pump failures or system changes. Cartridge filters will work, but because of the large amounts of brine shrimp, nauplii, and chopped foods needed to maintain healthy jellies, the cartridges tend to clog quickly which can reduce system turnover rates and lead to water quality issues. If used, they are best suited to the pressure side of a pump, and only if bag filters are employed to polish water entering the sump.

Although a jelly can withstand the higher ammonia levels associated with cycling a tank, adding the jellies during the cycling is not recommended. Jellies under stressful conditions produce copious amounts of slime, release gametes into the water, and may develop problems, such as pits on their bells. These conditions are rarely fatal, but all of them can cause problems to a system's balance and appearance.

Both the slime and gametes in the water can be removed with protein skimming. Unfortunately, protein skimmers require large quantities of fine air bubbles, so degassing effluent will be needed. If possible, run the effluent line from the protein skimmer into the filter bag and over bio balls in the wet/dry area of the sump. This can help to eliminate bubble problems. If planula larvae are released (which will happen with

adult moon jellies at some point) not all larvae will be removed by protein skimming, but it will help to control settlement and formation of polyps within the system.

Ozone is becoming more common in aquaria because it promotes water clarity and parasite control, but unless it (and its oxidant byproducts) can be fully neutralized before the water returns to the tank it should not be used. If added to the system in a contact chamber or protein skimmer, it should pass through an activated carbon filter before remixing with the tank water. As previously noted, other options such as UV sterilization will help control bacterial blooms and kill some pathogens, but planula larvae tend to pass through UV filters unharmed. This is good for when one is trying to raise polyps of a jelly, but unwanted hydroids or very prolific jellies such as moon jellies (*Aurelia* sp.) or upside-down jellies (*Cassiopea* sp.) will continue to spread.

Once the water has passed through the filter, the only challenge left is returning it to the tank. Since bubbles are a major problem for jellies, pump intakes should be toward the very bottom of the sump. Float switch shut offs can be added to prevent the sump from getting too low and air being pulled into the intake. A sump can be drained too low from evaporation, leaks, or most commonly an aquarist or volunteer who forgets to keep an eye on the level while changing water. Ball valves and check valves should be installed so water can be maintained in the pipes in case of such an event.

Water returns to jelly habitats should be regulated with a ball valve, but in some cases where a large pump is required, a side-stream of water may have to be diverted either back to the sump or used to supply filter mechanisms. If large flows for circulation in a large enclosure are required, multiple spray bars or a trickle plate with an acrylic deflecting piece might allow strong directional currents without the direct pressure that occurs at the outlets on a single spray bar. Pipe diameter, hole size and quantity on a spray bar can be manipulated to achieve ideal velocity and desired turnover rates within an enclosure.

The same careful consideration regarding exhibit size and complexity and its relationship to the jellyfish overall well-being must be given to the design and size of all enclosures, including those used in exhibits, holding areas, hospital, and quarantine/isolation (AZA Accreditation Standard 10.3.3). Sufficient shade must be provided by natural or artificial means when sunlight is likely to cause overheating or discomfort to the animals (AZA Accreditation Standard 10.3.4).

AZA Accreditation Standard

(10.3.3) All animal enclosures (exhibits, holding areas, hospital, and quarantine/isolation) must be of a size and complexity sufficient to provide for the animal's physical, social, and psychological well-being. AZA housing guidelines outlined in the Animal Care Manuals should be followed.

AZA Accreditation Standard

(10.3.4) When sunlight is likely to cause overheating of or discomfort to the animals, sufficient shade (in addition to shelter structures) must be provided by natural or artificial means to allow all animals kept outdoors to protect themselves from direct sunlight.

2.2 Safety and Containment

Animals housed in free-ranging environments should be carefully selected, monitored and treated humanely so that the safety of these animals and persons viewing them is ensured (AZA Accreditation Standard 11.3.3).

AZA Accreditation Standard

(11.3.3) Special attention must be given to free-ranging animals so that no undue threat is posed to either the institution's animals, the free-ranging animals, or the visiting public. Animals maintained where they will be in contact with the visiting public must be carefully monitored, and treated humanely at all times.

Species Selection: Species are usually chosen on the basis of:

1. Difficulty of species husbandry;
2. Available food sources;
3. Staff expertise;
4. Regional focus;
5. Availability of suitable aquarium tanks;
6. Species availability.

The following safety and containment considerations need to be taken into account when choosing to exhibit jellies:

- Jellyfish exhibit enclosures should have the normal sensor alarms that alert the aquarist in charge. These parameters include: temperature and water flow.
- Jellyfish exhibit enclosures should utilize designs that keep unsupervised visitors from having access to reaching into the displays. Jellyfish enclosures should have simple lids when their display is in public spaces. This will prevent people touching the jellies (except in the case of moon jellyfish touch tanks) and keep people from putting foreign objects into the aquarium.

- Except for some of the rhizostomid medusae, exhibit jellyfish must be kept in monospecies aquarium tanks both for their safety (they can be very delicate) and for the safety of other animals (jellyfish will sting when touched, and many jellyfish consume other jellies). *Chrysaora achlyos* has also been successfully housed with *Chrysaora colorata*.
- Jellyfish release planulae that can easily flow through the outflow and can colonize underwater surfaces. Planulae from one species of jelly can be accidentally introduced into the culturing container of another. To reduce this risk, aquarists should keep separate tools (e.g., basters, cleaning devices, glass jars, etc.) for each system. Also, care needs to be taken when food is being introduced that water from one aquarium doesn't get introduced from another aquarium filled with a different species of jellies that might have been releasing planulae. Using a 5 micron filter on polyp systems will help reduce cross contamination.
- It is also important to take measures not to release water from jelly systems into waterways where the jellies can be an invasive species. For this reason, water leaving coastal institutions should go to a water treatment facility.
- Jellyfish need to be kept in appropriate aquaria designed to meet their planktonic lifestyle.
- Jellyfish can be harmed by anything jutting into the aquaria. Care needs to be taken that jellies are kept away from overflow or drain screens attached to the aquaria. Plastic burrs or plastic cement slivers or shavings can be extremely harmful if undetected. New and renovated aquariums should be inspected by hand for such defects.

AZA Accreditation Standard

(11.3.1) All animal exhibits and holding areas must be secured to prevent unintentional animal egress.

AZA Accreditation Standard

(1.5.15) All animal exhibit and holding area air and water inflows and outflows must be securely protected to prevent animal injury or egress.

AZA Accreditation Standard

(2.8.1) Pest control management programs must be administered in such a manner that the animals, paid and unpaid staff, the public, and wildlife are not threatened by the pests, contamination from pests, or the control methods used.

AZA Accreditation Standard

(11.3.6) There must be barriers in place (for example, guardrails, fences, walls, etc.) of sufficient strength and/or design to deter public entry into animal exhibits or holding areas, and to deter public contact with animals in all areas where such contact is not intended.

AZA Accreditation Standard

(11.2.4) All emergency procedures must be written and provided to appropriate paid and unpaid staff. Appropriate emergency procedures must be readily available for reference in the event of an actual emergency.

AZA Accreditation Standard

(11.6.2) Security personnel, whether employed by the institution, or a provided and/or contracted service, must be trained to handle all emergencies in full accordance with the policies and procedures of the institution. In some cases, it is recognized that Security personnel may be in charge of the respective emergency (i.e. shooting teams).

Animal exhibits and holding areas in all AZA-accredited institutions must be secured to prevent unintentional animal egress (AZA Accreditation Standard 11.3.1). All animal exhibit and holding area air and water inflows and outflows must also be securely protected to prevent animal injury or egress (AZA Accreditation standard 1.5.15). Pest control methods must be administered so there is no threat to the animals, staff, public, and wildlife (AZA Accreditation Standard 2.8.1). Exhibit design must be considered carefully to ensure that all areas are secure and particular attention must be given to shift doors, gates, keeper access doors, locking mechanisms and exhibit barrier dimensions and construction.

The manifold and screen systems previously described are designed to prevent jellies from being injured by water entering or leaving their exhibits. The other items noted in this standard do not pertain to jellyfishes.

Exhibits in which the visiting public is not intended to have contact with animals must have a barrier of sufficient strength and/or design to deter such contact (AZA Accreditation Standard 11.3.6).

All emergency safety procedures must be clearly written, provided to appropriate paid and unpaid staff, and readily available for reference in the event of an actual emergency (AZA Accreditation Standard 11.2.4).

Staff training for emergencies must be undertaken and records of such training maintained. Security personnel must be trained to handle all emergencies in full accordance with the policies and procedures of

the institution and in some cases, may be in charge of the respective emergency (AZA Accreditation Standard 11.6.2).

Emergency drills must be conducted at least once annually for each basic type of emergency to ensure all staff is aware of emergency procedures and to identify potential problematic areas that may require adjustment. These drills must be recorded and results evaluated for compliance with emergency procedures, efficacy of paid/unpaid staff training, aspects of the emergency response that are deemed adequate are reinforced, and those requiring improvement are identified and modified (AZA Accreditation Standard 11.2.5). AZA-accredited institutions must have a communication system that can be quickly accessed in case of an emergency (AZA Accreditation Standard 11.2.6). A paid staff member or a committee must be designated as responsible for ensuring that all required emergency drills are conducted, recorded, and evaluated in accordance with AZA accreditation standards (AZA Accreditation Standard 11.2.0).

AZA-accredited institutions must also ensure that written protocols define how and when local police or other emergency agencies are contacted and specify response times to emergencies (AZA Accreditation Standard 11.2.7)

AZA-accredited institutions that care for potentially dangerous animals must have appropriate safety procedures in place to prevent attacks and injuries by these animals (AZA Accreditation Standards 11.5.2 and 11.5.3).

Animal attack emergency response procedures must be defined and personnel must be trained for these protocols (AZA Accreditation Standard 11.5.3).

Jellyfish Stings and First-Aid: The most dangerous emergency would probably be someone being stung by the jelly. The severity of jelly stings varies greatly amongst species. For instance, moon jellies rarely cause any sensation at all when touched with fingers. However, if someone went swimming in a “smack” (swarm) of moon jellies and bare skin came into contact with their tentacles, an itchy rash could develop. For jellies that can cause a painful sting, like purple-striped jellies (*Chrysaora colorata*) or black sea nettles (*Chrysaora achlyos*) one needs to be careful to reduce the chance of being stung. If a person is exposed to a jelly that stings strongly, the procedure is to remove the tentacle (if there is one on the skin) with a pair of tweezers. The person removing the tentacle should wear latex gloves to reduce the danger of being stung themselves. Once the tentacle is removed, vinegar can be applied to the affected area. The person should be monitored for the next 12–24 hours looking for symptoms that might develop. If symptoms do develop the person should be sent to a doctor noting which species of jelly was responsible for the sting. It is important to remember that someone could have an allergic reaction to even a moon jelly sting.

Staff or volunteers feeding jellies should wear gloves to reduce the danger of being stung. There is no danger of jellies stinging people outside their aquarium tanks. Security personnel may be called in to help prevent visitor access to an area where a jelly aquarium burst and jellies are on the ground.

AZA Accreditation Standard

(11.2.5) Live-action emergency drills (functional exercises) must be conducted at least once annually for each of the four basic types of emergency (fire; weather or other environmental emergency appropriate to the region; injury to visitor or paid/unpaid staff; and animal escape). Four separate drills are required. These drills must be recorded and results evaluated for compliance with emergency procedures, efficacy of paid/unpaid staff training, aspects of the emergency response that are deemed adequate are reinforced, and those requiring improvement are identified and modified. (See 11.5.2 and 11.7.4 for other required drills).

AZA Accreditation Standard

(11.2.6) The institution must have a communication system that can be quickly accessed in case of an emergency.

AZA Accreditation Standard

(11.2.0) A paid staff member or a committee must be designated as responsible for ensuring that all required emergency drills are conducted, recorded, and evaluated in accordance with AZA accreditation standards (see 11.2.5, 11.5.2, and 11.7.4).

AZA Accreditation Standard

(11.2.7) A written protocol should be developed involving local police or other emergency agencies and include response times to emergencies.

AZA Accreditation Standard

(11.5.3) Institutions maintaining potentially dangerous animals must have appropriate safety procedures in place to prevent attacks and injuries by these animals. Appropriate response procedures must also be in place to deal with an attack resulting in an injury. These procedures must be practiced routinely per the emergency drill requirements contained in these standards. Whenever injuries result from these incidents, a written account outlining the cause of the incident, how the injury was handled, and a description of any resulting changes to either the safety procedures or the physical facility must be prepared and maintained for five years from the date of the incident.

Chapter 3. Records

3.1 Definitions

In the zoo and aquarium world, animal records are defined as "data, regardless of physical form or medium, providing information about individual animals, samples or parts thereof, or groups of animals". Most animals in zoo and aquarium collections are recorded as (referred to as) individuals, though some types of animals are recorded as (referred to as) groups or colonies of animals, particularly with invertebrates and in aquariums (see Appendix B for definitions and Recordkeeping Guidelines for Group Accessions). The decision about how to record its animals usually resides with each institution, but in certain cases, the AZA Animal Program Leader (i.e., TAG Chair, SSP Coordinator, or Studbook Keeper) may request that animals be recorded in a certain manner, whether as individuals or as groups.

Jellyfish medusae and comb jellies are referred to as groups (without individual accession numbers) and jellyfish polyps are referred to as colonies.

AZA Accreditation Standard

(1.4.0) The institution must show evidence of having a zoological records management program for managing animal records, veterinary records, and other relevant information.

AZA Accreditation Standard

(1.4.6) A paid staff member must be designated as being responsible for the institution's animal record-keeping system. That person must be charged with establishing and maintaining the institution's animal records, as well as with keeping all paid and unpaid animal care staff members apprised of relevant laws and regulations regarding the institution's animals.

AZA Accreditation Standard

(1.4.7) Animal and veterinary records must be kept current.

AZA Accreditation Standard

(1.4.4) Animal records, whether in electronic or paper form, must be duplicated and stored in a separate location. Animal records are defined as data, regardless of physical form or medium, providing information about individual animals, or samples or parts thereof, or groups of animals.

AZA Accreditation Standard

(1.4.5) At least one set of the institution's historical animal and veterinary records must be stored and protected. Those records should include permits, titles, declaration forms, and other pertinent information.

AZA Accreditation Standard

(1.4.1) An animal inventory must be compiled at least once a year and include data regarding acquisition, transfer, euthanasia, release, and reintroduction.

3.2 Types of Records

There are many types of records kept for the animals in our care, including but not limited to, veterinary, husbandry, behavior, enrichment, nutrition and collection management. These types of records may be kept as separate records as logs in separate locations or as part of the collection records and some may be required by regulation agencies (e.g., primate enrichment records) or per AZA Accreditation Standards (e.g., emergency drill records).

Recordkeeping is an important element of animal care and ensures that information about individual animals or groups of animals is always available. The institution must show evidence of having a zoological records management program for managing animal records, veterinary records, and other relevant information (AZA Accreditation Standard 1.4.0). These records contain important information about an individual animal or group of animals, including but not limited to taxonomic name, transaction history, parentage, identifiers, gender, weights, enclosure locations and moves, and reproductive status (see Appendix C for Guidelines for Creating and Sharing Animal and Collection Records).

In addition to relevant husbandry data (e.g. water quality, culturing notes etc), institutions with jellyfish in their care should keep the following records and the date they occur at a minimum:

- Species
- Group or Individual ID number
- Group merges and splits
- Acquisition information (e.g., collection data, raised on-site, received as surplus animals from what institution).
- Disposition information (e.g., surplused to another institution).
- Transition (e.g., mortality records, including animals moved to feeder populations).

A designated paid staff member must be responsible for maintaining the animal recordkeeping system and for conveying relevant laws and regulations to the animal care staff (AZA Accreditation Standard 1.4.6). Recordkeeping must be accurate and current (AZA Accreditation Standard 1.4.7). Complete and up-to-date animal records must be duplicated and stored at a separate location (AZA Accreditation Standard 1.4.4) and at least one set of historical records safely stored and protected (AZA Accreditation Standard 1.4.5).

AZA Accreditation Standard

(1.4.2) All species owned by the institution must be listed on the inventory, including those animals on loan to and from the institution.

AZA member institutions must inventory their jellyfish population at least annually and document all jellyfish acquisitions, transfers, euthanasia (including transfers to feeder populations), releases, and reintroductions (AZA Accreditation Standard 1.4.1). All jellyfish owned by an AZA institution must be listed on the inventory, including those animals on loan to and from the institution (AZA Accreditation Standard 1.4.2). All AZA-accredited institutions must abide by the AZA Policy on Responsible Population Management (Appendix D) and the long-term welfare of animals should be considered in all acquisition and transfer decisions.

Inventory of jellyfish should follow institutional procedures on Responsible Population Management, which are done at least annually. Jellyfish are sometimes in such large groups that their numbers are listed as "too numerous to count" (TNTC) or approximated. Groups size can be estimated and monitored using a method known as incomplete counts. An incomplete count is performed by counting part of a population, in one quadrant of the tank for example, and then extrapolating to the entire population.

Polyps are virtually impossible to reliably enumerate due to their great capacity to bud new polyps asexually and are usually referred to as a colony. A sheet of asexually-reproducing polyps is essentially a single individual in terms of genetics.

3.3 Identification

Ensuring that jellyfish are identifiable through various means increases the ability to care for individuals more effectively. All animals held at AZA facilities must be individually identifiable whenever practical, and have corresponding identification (ID) numbers. For animals maintained in colonies or groups, or other animals not considered readily identifiable, institutions must have a procedure for identification of and recording information about these groups or colonies. (AZA Accreditation Standard 1.4.3). These IDs should be included in specimen, collection and/or transaction records and veterinary records. Types of identifiers include:

AZA Accreditation Standard

(1.4.3) Animals must be identifiable, whenever practical, and have corresponding ID numbers. For animals maintained in colonies/groups or other animals not considered readily identifiable, the institution must provide a statement explaining how record keeping is maintained.

Physical identifier: These include, but are not limited to, ear and/or wing tags, leg bands, tattoos, microchips/transponder and RFID devices, elastomers, ear and/or shell notches and toe clips. Permanent physical identifiers are often required when a species is regulated by a government agency and to distinguish separate animals in studbooks.

Intangible identifiers (called 'logical identifiers' in the Zoological Information Management System [ZIMS]): These include, but are not limited to, institutional accession number, house name, public name, studbook number, and ZIMS Global Accession Number.

Currently, there are no reliable methods for identifying or tagging individual jellyfish medusa or polyps. The current best practice to record jellyfish in human care is to count them as groups and/or colonies.

Chapter 4. Transport

4.1 Preparations

Animal transportation must be conducted in a manner that adheres to all laws, is safe, and minimizes risk to the animal(s), employees, and general public (AZA Accreditation Standard 1.5.11). All temporary, seasonal, and traveling live animal exhibits must meet the same accreditation standards as the institution's permanent resident animals, with foremost attention to animal welfare considerations (AZA Accreditation Standard 1.5.10). Safe animal transport requires the use of appropriate conveyance and equipment that is in good working order. Include copies of appropriate permits and authorizations in transport documentation. If the animal is not owned by the shipping institution, permission is to be obtained from the owner well in advance of the move.

AZA Accreditation Standard

(1.5.11) Animal transportation must be conducted in a manner that is safe, well-planned and coordinated, and minimizes risk to the animal(s), employees, and general public. All applicable laws and/or regulations must be adhered to.

The equipment must provide for the adequate containment, life support, comfort, temperature control, food/water, and safety of the animal(s).

AZA Accreditation Standard

(1.5.10) Temporary, seasonal and traveling live animal exhibits, programs, or presentations (regardless of ownership or contractual arrangements) must be maintained at the same level of care as the institution's permanent resident animals, with foremost attention to animal welfare considerations, both onsite and at the location where the animals are permanently housed.

Equipment Inspection Routines and Protocols: Jellyfish are often shared among institutions, therefore requiring transportation, either by ground or air. Jellies should not be fed the day of transport to reduce the waste products to foul the water in the bag. The jellies are carefully dipped out of their aquarium using a container that will hold water (never a net), and carefully transferred into plastic bags filled with seawater from their holding tank. The bags are sealed tightly with rubber bands and without an air pocket. Some aquarists have found that saturating the water with oxygen has been a good way to increase the survivability of jellies during shipping. If this is done, it is important to make sure all bubbles are gone before adding jellies (bubbles in the bags are sometimes entrained under the bell or ingested causing physical damage to the jellyfish). Double bagging helps prevent breakage. The size of the bag should be chosen according to the size and quantity of the jellies.

Standard fish bags 23 cm x 38 cm (9 in. x 15 in.), 3 mil bag holds 3 L (1 gal) of saltwater which will safely ship 1–4 juvenile 7.5 cm (3 in.) moon jellies, for example. Medusivores with a >7.5 cm (>3 in.) bell should be bagged individually.

- The sending and receiving institutions should communicate early and often to make sure all prerequisites are met prior to animals being shipped. e.g. Health certificates are often highly variable depending where the jellies will be imported. The receiving institution will know what is required on this document and it will be completed by the sending institution before the jellies depart.
- Each bag should be labeled with species, institution of origin, and date.
- The filled and sealed bags should be put into a styrofoam box with packing material to fill up any voids and prevent the jelly bags from tumbling around inside the box.
- A liner bag can be put into the styrofoam box as a third layer of plastic to help contain water that might leak from the shipping bags. This precaution can keep the corrugated box from losing integrity and prevent the shipment from being delayed.
- Temperature control is the main parameter that can be maintained during shipping. Either an ice pack or warm pack should be put into the styrofoam box to help maintain the temperature required by the jelly.
- The styrofoam box should have a lid that is sealed with tape and placed into a corrugated shipping box. Keeping the boxes under 18 kg (40 lb) each is advised.
- The shipping box should be sealed with tape and labeled with both the receiving institution's and the sender's address and phone number, and the appropriate shipping label.
- The outer box should be marked with notes such as "Live Animals," "Handle with Care," "Fragile," "This Side Up," etc. on all four sides. It should be assumed that the boxes will be dealt with rather

harshly by a shipping company(s) despite these labels and how the jellies are packaged should take this into account.

- The sending institution should inform the receiving institution when the box is in transit and share any tracking numbers for the shipment.
- As with most live shipments, jellies need to be sent overnight express (2-day transport maximum).
- Large plastic picnic coolers, such as Igloo® coolers, are a useful alternative to styrofoam/corrugated fish boxes. Coolers are less likely to be damaged or leak during longer ground transports but may not be feasible or cost effective for other transports.
- With proper packaging and handling, jellies may survive for 2–3 days before they start showing adverse effects from transportation stresses, such as lack of food, immobility, and temperature issues.

When air transport is involved, International Air Transport Association (IATA) live animal regulations should be followed. Jellyfish are considered "fish" under IATA regulations. More information can be found on the IATA-LAR website as well as a checklist for preparing shipments. The links are as follows, respectively: (https://www.iata.org/en/publications/store/live-animals-regulations/) and (https://www.iata.org/contentassets/d7c512eb9a704ba2a8056e3186a31921/en-lar-47-acceptance-checklist.pdf)

International transport of live jellyfish is a complex multi-agency process that requires a lot of preparation and paperwork. It can be a daunting task from both the exporting and importing side of the journey. Failure to complete all appropriate steps, requirements, and paperwork can result in the shipment being held longer than planned and additional stress for the animals. Fortunately, there are many businesses, such as customs brokers and aquatic animal wholesalers, that specialize in facilitating this process and in some cases their services may be required. Entities in the USA, and their international equivalents, that should be considered when exporting and importing jellyfish include, but are not limited to:

- State and/or Local regulations
- US Fish & Wildlife Service (USFWS)
  - Import/export permit
  - EDECS Form 3-177
- CITES
  - Currently there are no jellyfish species listed in Appendices I, II, or III
- Customs and Border Protection (enforces USDA/APHIS regulations)

Facilities with non-profit status may enjoy some exemptions, however these requirements are constantly changing, and it is extremely important for both the importing and exporting institutions to remain updated and compliant with current regulations. It is often very helpful to contact USFWS and other agencies at the port of origin and entry to let them know a shipment is being planned. They are always helpful and willing to offer guidance to avoid common errors that may derail a shipment.

A document package that includes all necessary forms, commercial invoices, packing slips, foreign import/export permits, health certificates as required, airway bills, and Certificate of Origin documents, just to name a few, must be submitted online to the USFWS a minimum of 48 hours prior to shipping. Copies of the document package should be shared with the receiving institution and customs broker (if needed) as well as accompany the shipment to its port of entry. There are also often landing fees, taxes, and inspection fees to be paid before the shipment can be released.

Safe long-distance transport also requires the assignment of an adequate number of appropriately trained personnel (by institution or contractor) who are equipped and prepared to handle contingencies and/or emergencies that may occur during transport. Planning and coordination for animal transport requires good communication among all affected parties, plans for a variety of emergencies and contingencies that may arise, and timely execution of the transport. At no time should the animal(s) or people be subjected to unnecessary risk or danger (AZA Accreditation Standard 1.5.11).

4.2 Protocols

Transport protocols should be well defined and clear to all animal care staff. Jellies that are taken off institutional grounds for education purposes should be kept in jars or sealable tubes that are filled to the

top to prevent bubbles. The temperature needs to be maintained with either ice packs or heat packs. Jellies should never be taken out of the water. Dipping them out with plastic bowls is the best way to move them from one vessel to another.

Acclimating the jellies once they return or arrive at the receiving institution is mandatory. Once the water temperature has equalized by floating the newly arrived and bagged jellies in their new enclosure, conduct small 20% water changes inside the bags over 30 minutes to 1 hour. This will ensure salinity and pH have also equalized. Water quality parameters vary from institution to institution and enclosure to enclosure. Allowing the jellies to adjust to their new environment takes time, patience, and observation. Close observation of the jellyfish behavior and water quality parameters will indicate when they are ready to be released into their new environment. Smooth even bell movement and neutral buoyancy are primary indicators that full acclimation is complete. Buoyancy is a key indicator because jellyfish, being 98% or more water, osmotically conform to the water in their environment. This is most obvious when introducing jellies to a new enclosure, as they will float (positive buoyancy) or sink (negative buoyancy) according to the specific gravity (salinity) of the new enclosure water. If the water in the receiving tank is saltier than the water the jellies came from, then the jellyfish will float. If the water in the receiving tank is less salty, then the jellyfish will sink. Jellyfish will naturally find equilibrium with the water around them over time. Acclimation time frames vary from species to species. Some acclimate very quickly while others do not. It is up to the jelly aquarist to observe and make this process as safe as possible for the jellies.

Chapter 5. Social Environment

5.1 Group Structure and Size

Careful consideration should be given to ensure that animal group structures and sizes meet the social, physical, and psychological well-being of those animals and facilitate species-appropriate behaviors.

Aquarists have tried to put different species of jellies together with mixed results. It is good to ask other aquarists via the AZA Jellyfish Network group (https://network.aza.org/communities/allcommunities) or personal communication for current findings on jellies that are compatible in the same tank.

5.2 Influence of Others and Conspecifics

Animals cared for by AZA-accredited institutions are often found residing with conspecifics but may also be found residing with animals of other species.

For the most part, jellyfish are displayed in single species groups. There has been some mixing of species of rhizostoma medusae in the same aquaria tanks with good results. If an aquarist does try a multispecies exhibit, close attention should be made to any deleterious effects and if detected, the jellies should be put back into single species tanks. Deleterious effects may include bell flattening, bell everting, flaccid oral arms, pitted bells, holes in the bell, or sloughing off of exumbrellar surface.

5.3 Introductions and Reintroductions

Managed care for and reproduction of animals housed in AZA-accredited institutions are dynamic processes. Animals born in or moved between and within institutions require introduction and sometimes reintroductions to other animals. It is important that all introductions are conducted in a manner that is safe for all animals and humans involved.

In general, medusoid jellies are moved from smaller tanks when young to larger tanks as they grow. There is no social structure in jellyfish. Medusoid jellies should be put with others of their own species and roughly the same size. Some medusoid jellyfish have the ability to eat younger stages of conspecifics. Every attempt should be taken to keep the polyp stage in single species enclosures. Some polyps can overgrow and kill other species of polyps or hydroids.

Jellies should be acclimated slowly when moving them to a new aquarium tank. Please refer to Chapter 4.2 for more in depth details on the acclimation of jellyfish.

Chapter 6. Nutrition

6.1 Nutritional Requirements

A formal nutrition program is required to meet the nutritional and behavioral needs of all species (AZA Accreditation Standard 2.6.2). Diets should be developed using the recommendations of nutritionists, the AZA Nutrition Scientific Advisory Group (NAG) feeding guidelines (http://nagonline.net/guidelines-aza-institutions/feeding-guidelines/), and veterinarians as well as AZA Taxon Advisory Groups (TAGs), and Species Survival Plan® (SSP) Programs. Diet formulation criteria should address the animal's nutritional needs, feeding ecology, as well as individual and natural histories to ensure that species-specific feeding patterns and behaviors are stimulated.

AZA Accreditation Standard

(2.6.2) The institution must follow a written nutrition program that meets the behavioral and nutritional needs of all species, individuals, and colonies/groups in the institution. Animal diets must be of a quality and quantity suitable for each animal's nutritional and psychological needs.

Jellyfish are opportunistic planktivores in their natural environments. They possess the ability to feed 24 hours a day and can grow very fast. As an example, upside down jellies, *Cassiopea* spp., derive most of their nutrition from symbiotic zooxanthellae that are hosted in the epidermis (Hofmann & Kremer, 1981; Rahat & Adan, 1980). For jellies hosting symbiotic zooxanthellae, lighting with natural wavelengths is critical to keeping them healthy in public displays (see Chapter 1.2).

Nutrient requirements (or target nutrient values) are unknown for jellies. Most jellies are carnivorous and there are a number of foods that have been found to work well for achieving success in culture and display. Ideally, analyzed nutrient composition of those food items would help us better assess what they provide to the jellies. Keep in mind also that the various life history stages of jellies need to be fed foods of appropriate size and type throughout their development. Very often the diet changes for a given species as it matures. For example, planulae eat nothing, newly settled scyphistomae (also known as "polyps") due to small mouth size, eat *Artemia* nauplii and rotifers, and ephyrae may eat rotifers and *Artemia* nauplii, but as they grow may require additional foods such as gelatinous zooplankton. Large medusae may eat all of the previously mentioned foods with the addition of small krill and fishes.

Hydrozoan medusae are often smaller than scyphozoan medusae and they too are planktivorous. In aquariums they are often fed enriched rotifers, *Artemia nauplii* and wild plankton. One common hydrozoan medusa in public displays is the crystal jelly *Aequorea victoria*. In order for the crystal jelly to display its bioluminescence it needs to be fed live wild organisms that possess the light emitting compound luciferin (Haddock et al., 2001). For an overview on jelly nutrition in aquariums, one may refer to How to Keep Jellyfish in Aquariums by Chad Widmer (2008). Widmer includes recommended foods for each life history stage of many commonly displayed jellyfish.

Some jellies such as the egg yolk jellyfish, *Phacellophora camtschatica*, specialize in eating other species of jellyfish. Medusivores (genera *Chrysaora*, *Cyanea* and *Phacellophora* among others) often do not grow well unless their diet is supplemented with other jellies. The most commonly utilized jelly for feeding medusivorous jellies in aquariums is the moon jelly (*Aurelia* sp.). For this reason, aquarists should have a sustainable supply of moon jellies to use as food.

6.2 Diets

The formulation, preparation, and delivery of all diets must be of a quality and quantity suitable to meet the animal's nutritional and psychological needs (AZA Accreditation Standard 2.6.2). Food should be purchased from reliable, sustainable and well-managed sources. The nutritional analysis of the food should be regularly tested and recorded.

Many institutions have fine-tuned their diets based upon the responses seen in the jellies they keep. In general, jellies should be fed every day. Many aquariums feed their collections two to three times per day since in the wild they have the potential to feed 24-hours a day. Automatic feeders may be used to deliver small portions of *Artemia* nauplii to displays round the clock.

A variety of live and frozen foods that have been used to culture many species of jellies:

- Rotifers, *Brachionus* spp.
- *Artemia* (brine shrimp) nauplii
- Mysids

- Krill (euphausiid shrimp)
- Blood worms
- Blended fish such as “salmon shakes,” filtered as needed to remove the finest particles that may not be used and will cloud the water
- Fish eggs
- Larval fish
- Wild plankton
- Other jellies (commonly moon jellies, chopped to appropriate size.)

It is often beneficial to feed specialized diets to live food items that are fed to jellyfish. The idea behind this feeding enrichment is a food chain approach that “gut loads” rotifers and *Artemia* nauplii so food contained in the gastrointestinal (GI) tract can be utilized by the jellies. Without enrichment there is little nutritional value to rotifers and *Artemia* nauplii for jellies. Jellyfish fed non-enriched diets often fail to thrive, grow very slowly if at all, or simply perish. The cost of replacing jellyfish far outweighs the expense of common food enrichment supplements. The most common enrichment supplements include phytoplankton (such as *Isochrysis* and *Nannochloropsis*) and commercially available media (e.g., Algamac 3050™ from Aquafauna, or Selco™ from INVE).

Regulations on storage and thawing of seafood also apply to organisms used for jelly diets.

Food preparation must be performed in accordance with all relevant federal, state, or local laws and/or regulations (AZA Accreditation Standard 2.6.1). Meat processed on site must be processed following all USDA standards. The appropriate hazard analysis and critical control points (HACCP) food safety protocols for the diet ingredients, diet preparation, and diet administration should be established for jellyfish. Diet preparation staff should remain current on food recalls, updates, and regulations per USDA/FDA. Remove food within a maximum of 24 hours of being offered unless state or federal regulations specify otherwise and dispose of per USDA guidelines.

AZA Accreditation Standard

(2.6.1) Animal food preparation and storage must meet all applicable laws and/or regulations.

AZA Accreditation Standard

(2.6.3) The institution must assign at least one paid or unpaid staff member to oversee appropriate browse material for the animals (including aquatic animals).

6.3 Nutritional Evaluations

The health of aquarium jellies is evaluated by comparing their body condition to those observed in the wild. Some abnormalities to watch for are bell flattening, or curling of the margin, bell everting, flaccid oral arms, pitted bells, holes through the bell, pulsing abnormally, and sloughing off of exumbrellar surface, and thin transparent bells (when the bells are meant to be opaque).

The routine analysis of pre- and post-gut loaded live prey items is extremely valuable to help further determine the nutrient needs of managed jellies.

Chapter 7. Veterinary Care

7.1 Veterinary Services

Veterinary services are a vital component of excellent animal care practices. A full-time staff veterinarian is recommended; however, in cases where this is not necessary, a consulting/part-time veterinarian must be under contract to make at least twice monthly inspections of the animal collection and to respond to any emergencies (AZA Accreditation Standard 2.1.1). In some instances, because of their size or nature, exceptions may be made to the twice-monthly inspection requirement for certain institutions (e.g., insects only, etc.). Veterinary coverage must also be available at all times so that any indications of disease, injury, or stress may be responded to in a timely manner (AZA Accreditation Standard 2.1.2). All AZA-accredited institutions should adopt the guidelines for medical programs developed by the American Association of Zoo Veterinarians (AAZV), available at the AAZV website at https://cdn.ymaws.com/www.aazv.org/resource/resmgr/files/aazvveterinaryguidelines2016.pdf (AZA Accreditation Standard 2.0.1).

AZA Accreditation Standard

(2.1.1) A full-time staff veterinarian is recommended. In cases where such is not necessary because of the number and/or nature of the animals residing there, a consulting/part-time veterinarian must be under written contract to make at least twice monthly inspections of the animals and to respond as soon as possible to any emergencies.

Few veterinarians have aquatic invertebrates as their specialty, much less know a lot about jelly health. The condition of jellies should be monitored daily and a veterinarian or other jellyfish experts should be consulted for advice if jellies appear differently from their wild morphological "standard". The tank environment must be also considered if health issues arise. Conditions such as flow, cleanliness, crowding, etc. should be evaluated, as a poor environment can rapidly and negatively affect jellyfish health.

Protocols for the use and security of drugs used for veterinary purposes must be formally written and available to paid and unpaid animal care staff (AZA Accreditation Standard 2.2.1). Procedures should include, but are not limited to: a list of persons authorized to administer animal drugs, situations in which they are to be utilized, location of animal drugs and those persons with access to them, and emergency procedures in the event of accidental human exposure.

Drugs are not commonly used with jellies. However, there has been successful eradication of crustacean parasites using the antiparasitic drug milbemycin oxime (Interceptor) and with the chiton inhibitor diflubenzuron (Dimilin). Attempts have been made to treat "bell rot" with tetracycline baths, yielding mixed results (see Chapter 7.7).

Veterinary recordkeeping is an important element of animal care and ensures that information about individual animals and their treatment is always available. A designated staff member should be responsible for maintaining accurate animal veterinary record keeping.

Jellies do not have accepted health-related factors at this time, nor does any agency regulate their care. It is recommended that feeding data, any indication of reproductive activity, unusual behavior or appearance changes be recorded as part of daily record keeping protocols.

AZA Accreditation Standard

(2.1.2) So that indications of disease, injury, or stress may be dealt with promptly, veterinary coverage must be available to the animals 24 hours a day, 7 days a week.

AZA Accreditation Standard

(2.0.1) The institution should adopt the *Guidelines for Zoo and Aquarium Veterinary Medical Programs and Veterinary Hospitals,* and policies developed or supported by the American Association of Zoo Veterinarians (AAZV). The most recent edition of the medical programs and hospitals booklet is available at the AAZV website, under "Publications", at https://cdn.ymaws.com/www.aazv.org/resource/resmgr/files/aazvveterinaryguidelines2016.pdf and can also be obtained in PDF format by contacting AZA staff.

AZA Accreditation Standard

(2.2.1) Written, formal procedures must be available to paid and unpaid animal care staff for the use of animal drugs for veterinary purposes, and appropriate security of the drugs must be provided.

7.2 Transfer Examination and Diagnostic Testing Recommendations

The transfer of animals between AZA-accredited institutions or certified related facilities due to AZA Animal Program recommendations occurs often as part of a concerted effort to preserve these species. These transfers should be done as altruistically as possible and the costs associated with specific examination and diagnostic testing for determining the health of these animals should be considered.

Aquariums and zoos commonly share jellies. A simple review of morphological characteristics such as bell, oral arm, and tentacle morphology as well as behavioral characteristics such as normal pulsing patterns and strength of pulse are all commonly employed to determine if the animals are acceptable for transfer.

7.3 Quarantine

AZA institutions must have holding facilities or procedures for the quarantine of newly arrived animals and isolation facilities or procedures for the treatment of sick/injured animals. Quarantine duration should be assessed and determined by the pathogen risk and best practice for animal welfare (AZA Accreditation Standard 2.7.1). All quarantine, hospital, and isolation areas should be in compliance with AZA standards/guidelines (AZA Accreditation Standard 2.7.3; Appendix E). All quarantine procedures should be supervised by a veterinarian, formally written and available to paid and unpaid staff working with quarantined animals (AZA Accreditation Standard 2.7.2). If a specific quarantine facility is not present, then newly acquired animals should be kept separate from the established collection to prohibit physical contact, prevent disease transmission, and avoid aerosol and drainage contamination. If the receiving institution lacks appropriate facilities for quarantine, pre-shipment quarantine at an AZA or American Association for Laboratory Animal Science (AALAS) accredited institution may be applicable. Local, state, or federal regulations that are more stringent than AZA Standards and recommendation have precedence.

Newly acquired jellies should be put into quarantine aquarium tanks off exhibit, if possible, and observed closely for several days to assure they are in good health. Their health can be determined by observing normal morphology, movement, and feeding for the species. Initial observations should determine the presence of damage from collecting or shipping, and the presence of any possible pathogens or parasites.

AZA institutions must have zoonotic disease prevention procedures and training protocols established to minimize the risk of transferable diseases (AZA Accreditation Standard 11.1.2) with all animals, including those newly acquired in quarantine. Keepers should be designated to care only for quarantined animals if possible. If keepers must care for both quarantined and resident animals of the same class, they should care for the quarantined animals only after caring for the resident animals. Care should be taken to ensure that these keepers are “decontaminated” before caring for the healthy resident animals again. Equipment used to feed, care for, and enrich animals in quarantine should be used only with these animals. If this is not possible, then all items must be appropriately disinfected, as designated by the veterinarian supervising quarantine before use with resident animals.

AZA Accreditation Standard

(2.7.1) The institution must have holding facilities or procedures for the quarantine of newly arrived animals and isolation facilities or procedures for the treatment of sick/injured animals. Quarantine duration should be assessed and determined by the pathogen risk and best practice for animal welfare.

AZA Accreditation Standard

(2.7.3) Quarantine, hospital, and isolation areas should be in compliance with standards/guidelines contained within the *Guidelines for Zoo and Aquarium Veterinary Medical Programs and Veterinary Hospitals* developed by the American Association of Zoo Veterinarians (AAZV), which can be obtained at: https://cdn.ymaws.com/www.aazv.org/resource/resmgr/files/aazvveterinaryguidelines2016.pdf

AZA Accreditation Standard

(2.7.2) Written, formal procedures for quarantine must be available and familiar to all paid and unpaid staff working with quarantined animals.

AZA Accreditation Standard

(11.1.2) Training and procedures must be in place regarding zoonotic diseases.

Feeding equipment, such as basters, containers, and nets, should be rinsed well with freshwater and allowed to dry between uses. This practice limits the possibility of introducing infectious diseases or planulae from other jelly species into a system. Other methods to prevent cross-contamination of planulae, parasites, or diseases include bleaching all tools and utensils once a week. Color coding tools and utensils to use with respective jelly culture systems further reduces cross-contamination of cultures and populations.

Jellies should stay in quarantine until they eat regularly, which could be several days to a week. Jellies in quarantine should also be observed for a few days to assure they are in good health and condition. Their health can be determined by observing normal morphology, movement, and feeding for the species. There are no recommended diagnostic tests for determining the health of jellies in quarantine. Minor bell damage often begins to heal noticeably in a few days, allowing microbial causes to be eliminated from consideration.

Parasites may infect wild jellies and careful examination for ectoparasites needs to be done when acquiring a wild population of jellies. The most common ectoparasites of jellies are copepods or hyperiid amphipods. There are several methods for removing these parasites. Information on the removal of ectoparasites and treatments using parasiticides can be found in Chapter 7.6. When jellies exhibit normal morphology, movement, and feeding for the species, and are free of parasites that can potentially spread through a larger population of jellies, they can be moved into exhibit tanks.

AZA Accreditation Standard

(2.5.1) Deceased animals should be necropsied to determine the cause of death for tracking morbidity and mortality trends to strengthen the program of veterinary care and meet SSP-related requests.

If an animal should die in quarantine, a necropsy should be performed on it to determine cause of death in order to strengthen the program of veterinary care and meet SSP-related requests (AZA Accreditation Standard 2.5.1). The institution should have an area dedicated to performing necropsies, and the subsequent disposal of the body must be done in accordance with any local or federal laws (AZA Accreditation Standards 2.5.2 and 2.5.3). If the animal is on loan from another facility, the loan agreement should be consulted as to the owner's wishes for disposition of the carcass; if nothing is stated, the owner should be consulted. Necropsies should include a detailed external and internal gross morphological examination and representative tissue samples from the body organs should be submitted for histopathological examination (see Chapter 7.6).

AZA Accreditation Standard

(2.5.2) The institution should have an area dedicated to performing necropsies.

AZA Accreditation Standard

(2.5.3) Cadavers must be kept in a dedicated storage area before and after necropsy. Remains must be disposed of in accordance with local/federal laws.

Medusoid stages of jellies are relatively short-lived animals (most less than one year). Senescence is common in adult jellies of mixed ages and may be seen in a group of jellies in quarantine. If the condition of the entire group is poor and suggests a health problem, examination for parasites can be performed. Another possibility is culturing for bacteria, although it is difficult to isolate specific pathogens from jellyfish. There are no local or federal laws concerning necropsy procedures for jellies. Neither are there published or accepted procedures for necropsy procedures for jellies.

AZA Accreditation Standard

(2.0.2) The veterinary care program must emphasize disease prevention.

AZA Accreditation Standard

(2.0.3) Institutions should be aware of and prepared for periodic disease outbreaks in wild or other domestic or exotic animal populations that might affect the institution's animals (ex – Avian Influenza, Eastern Equine Encephalitis Virus, etc.). Plans should be developed that outline steps to be taken to protect the institution's animals in these situations.

7.4 Preventive Medicine

AZA-accredited institutions should have an extensive veterinary program that must emphasize disease prevention (AZA Accreditation Standard 2.0.2). AZA institutions should be aware of and prepared for periodic disease outbreaks in other animal populations that might affect the institution's animals, and should develop plans to protect the institution's animals in these situations (AZA Accreditation Standard 2.0.3). The American Association of Zoo Veterinarians (AAZV) has developed an outline of an effective preventative veterinary medicine program that should be implemented to ensure proactive veterinary care for all animals (https://cdn.ymaws.com/www.aazv.org/resource/resmgr/files/aazvveterinaryguidelines2016.pdf).

Few veterinarians specialize in aquatic invertebrates, much less know a lot about jelly health, which is still an emerging science. Unlike many invertebrates studied as aquaculture subjects, few studies of disease in medusae exist. The condition of jellies should be monitored daily and a veterinarian should be consulted for advice if jellies exhibit behavior abnormal from the wild condition. Water quality maintenance and general tank and life support system maintenance are always good ways to maintain healthy jellies. It has been said, "cleanliness is close to jelliness."

Animals that are taken off zoo/aquarium grounds for any purpose have the potential to be exposed to infectious agents that could spread to the rest of the institution's healthy population. AZA-accredited institutions must have adequate protocols in place to avoid this (AZA Accreditation Standard 1.5.5).

AZA Accreditation Standard

(1.5.5) For animals used in offsite programs and for educational purposes, the institution must have adequate protocols in place to protect the rest of the animals at the institution from exposure to infectious agents.

Jellies are not often used as ambassador animals and if they are, they should not be taken out of the seawater they are kept in from their original exhibit. No human or environmental infectious agents are known to be transmittable to or from jellies.

Zoonotic diseases have not been identified that are specific to jellies. General precautions are the same as for any aquarium. Vigilance is needed regarding aquatic water borne zoonotic sources like *Mycobacterium marinum* (e.g., wash hands, avoid contact if immunocompromised, wear gloves).

A tuberculin testing and surveillance program must be established for paid and unpaid animal care staff, as appropriate, to protect the health of both staff and animals (AZA Accreditation Standard 11.1.3). Depending on the disease and history of the animals, testing protocols for animals may vary from an initial quarantine test, to annual repetitions of diagnostic tests as determined by the veterinarian. To prevent specific disease transmission, vaccinations should be updated as appropriate for the species.

AZA Accreditation Standard

(11.1.3) A tuberculin (TB) testing/surveillance program must be established for appropriate paid and unpaid staff in order to assure the health of both the paid and unpaid staff and the animals.

Tuberculin testing is not required for animal care staff working with jellies. While TB testing is not needed for working with fishes and aquatic invertebrates, testing sometimes becomes an issue at institutions that also house tetrapods. Misleading TB test positives have been reported in individuals that have been previously infected with *Mycobacterium marinum* (i.e., fish tank granuloma). *M. marinum* has low pathenogenicity in humans, and typically is limited to skin lesions.

7.5 Capture, Restraint, and Immobilization

The need for capturing, restraining and/or immobilizing an animal for normal or emergency husbandry procedures may be required. All capture equipment must be in good working order and available to authorized and trained animal care staff at all times (AZA Accreditation Standard 2.3.1).

AZA Accreditation Standard

(2.3.1) Capture equipment must be in good working order and available to authorized, trained personnel at all times.

Jellies can be harmed if picked up by hand or net. Their bodies need to be in water at all times. Most aquarists move them in bowls or plastic bags. Maneuver the animal to the surface using a swirling or vortex motion with your hand or extension "wand" (e.g., pvc pipe) in a clock-wise motion if it is not circumnavigating the tank normally and arriving at the surface on its own. Once at the top, use gentle but constant action drawing water slowly into the container or bag, pulling the jelly with it. Should a jelly be exposed to air, an inspection should be done to ensure that air is not trapped below the bell. Air trapped under a jellyfish bell can be fatal and needs to be addressed immediately. If air bubbles are discovered, the jelly should be turned upside down to allow the bubbles to escape. A gentle tapping of the bell from below may be necessary to dislodge the air bubbles.

7.6 Management of Diseases, Disorders, Injuries and/or Isolation

AZA-accredited institutions should have an extensive veterinary program that manages animal diseases, disorders, or injuries and has the ability to isolate these animals in a hospital setting for treatment if necessary. The owner of an animal on loan at a facility is to be consulted prior to any elective invasive procedures, including permanent contraception.

AZA Accreditation Standard

(2.1.3) Paid and unpaid animal care staff should be trained to assess welfare and recognize abnormal behavior and clinical signs of illness and have knowledge of the diets, husbandry (including enrichment items and strategies), and restraint procedures required for the animals under their care. However, animal care staff (paid and unpaid) must not diagnose illnesses nor prescribe treatment.

Jellyfish care staff should be trained in meeting the animal's dietary, husbandry, and enrichment needs, as well as in restraint techniques. Staff should also be trained to assess animal welfare and recognize behavioral indicators animals may display if their health becomes compromised, however, animal care staff should not diagnose illnesses nor prescribe treatment (AZA Accreditation Standard 2.1.3). Protocols should be established for reporting these observations to the veterinary department. Hospital facilities must have radiographic equipment or access to radiographic services (AZA Accreditation Standard 2.3.2), contain appropriate equipment and supplies on hand for treatment of diseases, disorders or injuries, and have staff available that are trained to address health issues, manage short- and long-term medical treatments and control for zoonotic disease transmission.

AZA Accreditation Standard

(2.3.2) Institution facilities must have radiographic equipment or have access to radiographic services.

Jellies can exhibit a variety of abnormal morphology or behaviors that can be indicators of poor health. Jellies showing abnormal morphology for the species (e.g., tattered or shrinking bells, oral arms too long or too short or hanging abnormally, everted bells, loss of tentacles) or abnormal behavior (ineffective bell movement, general lethargy or lack of feeding) should be considered for removal to quarantine areas if available. Those jellies that show no improvement should be considered for euthanizing.

Jellyfish Disease and Parasites

Very little is known about jellyfish diseases. Most of what has been observed and published has been about parasites of jellies. Often organisms are found in some type of close relationship with a jelly where it is not known if the organism is truly a parasite or simply a commensal, or if the observation is a random chance encounter that is rarely found in nature. Several reviews of diseases and parasites of jellyfish have been published and are cited in the reference section. Chapter 6 (*Diseases of Cnidaria*) from *Diseases of Marine Animals* Volume 1 (Kinne, 1980) has been used extensively for this chapter. The paper by Laval (1980) on hyperiid amphipods as parasitoids to gelatinous zooplankton was also used to a large degree. Due to a general scarcity of published material, personal communication has also been used and sources are cited throughout the text.

Although bacterial diseases have been discovered infecting coral reefs and incidents of infections of corals in aquariums are not uncommon, there is very little evidence of viral, bacterial, or fungal disease of marine cnidarians in the wild. Occasionally medusae, especially larger and/or older medusae, develop lesions or irregularities on the surface or at the margins of the bell. This is not uncommon, and is often referred to as "bell rot." It could be a dimpling of the surface or small "craters," which can eventually descend into the viscera. Sometimes there is an erosion of the margins and loss of marginal tentacles. One aquarium reported the development of a white caseous material forming on the surface along with the lesions, but no positive identification was made (S. Crossley, personal communication). Bacterial involvement in these bell problems is the subject of much discussions and speculation. At this point, there is no proven cause and effect relationship between bacteria and lesions on the bells of jellies, although it cannot be ruled out. There is also a possibility of secondary bacterial infection after the occurrence of some insult to the integument. It is difficult to obtain accurate isolated bacterial cultures from jellyfish. LaDouceur et al. examined a population of moon jellies (*Aurelia aurita)* in human care that had developed exumbrellar ulcers. Bacteria were not consistently associated with these lesions. Other types of infectious agents, such as viruses, fungi, or algae, were not discovered by electron microscopy or fungal culture. Trauma and environmental stress were proposed as possible causes for the ulcers.

A treatment for suspected bacterial infection reported to have had success is a 5-day course of 2-hour tetracycline baths, using the drug at 20 ppm (Raskoff et al., 2003). In the reported case where the caseous material developed, bacterial cultures were collected from the material. Two species of *Pseudomonas* and a *Streptococcus* were isolated. The cultured bacterial isolates were found to be sensitive to tetracycline. The jellies seemed to respond initially to the treatment described above, but ultimately died (S. Crossley, personal communication). At the Monterey Bay Aquarium, some success treating bacterial infections with the tetracycline treatment was observed, but after treatments the jellies slowly senesced (B. Upton, personal communication). Vancouver Aquarium reports success when treating *Cyanea* and *Catostylus* for bacterial infections using oxytetracycline and enrofloxacin (2 mg/L). The treatments were 6-hour baths every other day for 3 days. At this time, there is much research still to be done to find reliable antibiotic treatments for treating bell erosion problems found in managed jellies.

Although protozoans cause many common and well-known health problems in fishes and some other aquatic taxa, there is little evidence of protozoans causing health problems in scyphozoan or marine hydrozoans. Ciliates and other protozoans may be found secondarily in lesions, but there is no evidence that they are the cause of such lesions.

Intermediate stages of digenetic trematodes have been reported in several species of scyphozoan medusae, including *Chrysaora quinquecirrha*, *Pelagia noctiluca,* and *Cotylorhiza tuberculata*. There have also been reports of digenes in a number of hydrozoan medusae. Fishes are the definitive host of these reported digene species, which ultimately take up residence in the host's gastrointestinal system. There are numerous species of fishes that associate with and/or prey upon jellies (Arai, 1988) and jellies (including ctenophores) may be important intermediate hosts for a number of trematode species (Martorelli, 2001).

The cannonball jelly (*Stomolophus meleagris)* is sometimes infected by cestode larva (Phillips & Levin, 1973). The larva burrows in mesogleal tissue; large bacterial populations are associated with some of these burrows. It is assumed that fishes serve as the definitive host for the cestode, as a large variety of fishes associate with *Stomolophus* and/or utilize it as a food source. Cestodes have also been reported to infect Ctenophores, including *Beroe* and *Pleurobrachia* (Theodorides, 1989).

Although it is of interest to aquarists collecting and displaying certain species of jellies from the wild, it is unlikely that trematodes or cestodes would be a major problem for aquarists keeping jellies in closed systems using cultured animals. The burrowing sea anemone (*Peachia quinquecapitata)* can be found as an ectoparasite on hydrozoan medusae. Spaulding (1972) reviewed this anemone's life cycle and concluded that it is an obligate parasite during its larval development. The *Peachia* planula is ingested by the host and spends a short period of time in the radial canals before moving and attaching to the outside. There it feeds on gonads and other body tissue of the medusa host. In the laboratory, *Peachia* were able to move from one jelly host to another if given the opportunity.

On the Pacific coast of the U.S., larval *Peachia quinquecapitata* can be found on several species of hydromedusae (Spaulding, 1972; D. Wrobel, personal communication). Other species of *Peachia* have been observed attached to medusae in European and Australian waters (Lauckner, 1980). *Peachia* adults are free-living. They burrow in sand or gravel after leaving their host medusa by falling off or after the death of the host.

The larva of another burrowing sea anemone, *Edwardsiella lineata,* is a common parasite of the lobate ctenophore *Mnemiopsis leidyi* along the east coast of the US. It burrows into the mesoglea and inserts its mouth into the aboral end of the ctenophore's pharynx. There it feeds on food previously ingested by the ctenophore. This anemone parasite exhibits a high degree of host specificity, and as many as 30 individuals per host have been found (Bumann & Puls, 1996). When parasitized by *Edwardsiella*, growth in *Mnemiopsis* is insignificant or negative (Bumann & Puls, 1996). In a laboratory observation, Crowell (1976) observed liberated *Edwardsiella* enter uninfected *Mnemiopsis*. This has significance to the comb jelly culture aquarist. It is recommended that infected *Mnemiopsis* be removed from a population of uninfected animals if possible. It is often not possible to do this, as the percentage of infected *Mnemiopsis* in the wild is very high when this parasite appears. Due to the high host specificity, it is unlikely that *Edwardsiella* will spread to other jellies in a collection. At New England Aquarium, they have never been observed in any jelly other than *Mnemiopsis* in over a period of roughly 18 years. This despite the frequent holding and exhibition of infected *Mnemiopsis* in systems linked with other tanks holding scyphozoan and hydrozoan medusae and other species of ctenophores.

The most commonly encountered parasites of jellyfish and the ones that are of most concern for purposes of husbandry are crustaceans, especially the hyperiid amphipods. Other crustaceans that parasitize or associate with jellies are the pedunculate (or stalked) barnacles, most commonly *Alepas pacifica,* and several species of decapod crustaceans which "hitchhike" on medusae, especially during early stages of their lives. In addition, one case of a sea spider (class *Pycnogonida*) has been reported as a parasite on the mesopelagic scyphomedusae *Periphylla periphylla* (Child & Harbison, 1986).

Pages (2000) reviewed the literature on barnacles attached to jellies in the wild. Most reports were of the pedunculate barnacle *Alepas pacifica* attached to at least nine species of jellies, including *Pelagia noctiluca* and *Phacellophora camtschatica. A. pacifica* has also been found on *Chrysaora colorata* (C. Widmer, personal communication). Geographical location is widespread, encompassing the Atlantic, Pacific, and Indian Oceans. This stalked barnacle has highly reduced calcified plates, apparently to decrease its weight as a modification for attachment to swimming jellies. Pages proposed that the barnacle feeds upon the gonads of the jellies. Observations of the barnacle manipulating and removing captured

food from the tentacles of medusae have been observed at the Monterey Bay Aquarium (C. Widmer, personal communication).

Decapod crustaceans commonly "hitchhike" upon jelly medusae, especially when they are in a juvenile stage. On the Pacific coast of the U.S., larval and juvenile slender crabs (*Cancer gracilis*) can often be found on larger scyphozoans like *Chrysaora colorata, C. fuscescens,* and *Phacellophora camtschatica* before assuming their normal free-living benthic lifestyle (D. Wrobel, personal communication). At one aquarium *C. gracilis* was allowed to stay on *C. fuscescens* on display to eat hyperiid amphipods that might come in with the jellyfish. The crabs were removed when they reached a size that their legs might damage the soft jelly bells (C. Widmer, personal communication). On the Atlantic Coast of the U.S., larval and juvenile spider crabs (*Libinia dubia)* take up residence on *Aurelia aurita* and *Stomolophus meleagris* in much the same fashion as *C. gracilis* does. (Jachowski, 1963; Tunberg & Reed, 2004) These small crabs will eat food gathered by the host jelly but may also feed on host tissue. There may be several individuals residing on a single medusa. Adult *L. dubia* are free-living.

When found on a collected jelly, these decapod crabs can usually be removed quite easily with some blunt forceps. They do not attach to the jelly and are easily manipulated into a position where removal can be done without injury to the jelly. Since these crabs are only found on jellies during their immature stages, there is no danger of larvae being left behind.

Copepods are often encountered on wild *Catostylus mosaicus,* or blue blubber jelly. The relationship between these copepods and the host jelly may not be parasitic. Browne and Kingsford (2005) concluded that the copepod *Paramacrochiron maximum* was a commensal on *C. mosaicus* and were consuming mucous produced by the host (but not harming the jelly). Regardless, they can be present in large numbers and can be alarming when found. There is also the possibility of spreading to other jellies that may possibly be harmed by the copepod. We don't know much about host specificity or potential for harm in a closed system vs. the ocean environment.

A successful treatment to remove these copepods was reported by the Horniman Museum and Gardens in London (Jamie Craggs, personal communication). A treatment using Milbemax™ (Milbemycin oxime & Praziquantel) at 0.016mg/liter was done periodically over the course of 3-4 weeks. The copepods were reported to be dead or moribund and there were no harmful effects on the jellyfish.

Amphipods of the suborder Hyperiidae are entirely marine and pelagic, and not normally found inshore; as compared to the more commonly encountered amphipods of the suborder Gammaridae, which are almost entirely benthic and are common inshore. The hyperiids also differ from the gammarids in that they have large heads made up almost entirely of a pair of eyes. As stated earlier, the hyperiid amphipods are the most common and the most serious parasite encountered by aquarists collecting or exhibiting wild-collected jellies. There is ample documentation of infestation of both scyphozoan and hydrozoan medusae by hyperiids. Hyperiids are also known to infect ctenophores, siphonophores, and salps. Especially common on jellyfish are those of the genus *Hyperia. Hyperia galba* is one of the most well-known species, and has a cosmopolitan distribution. It has been reported in association with *Aurelia aurita, Cyanea capillata, Pelagia noctiluca* and several other scyphozoan species (Kinne, 1980). *Hyperia medusarum* can often be found attached to jellies of the Pacific coast of the U.S. Hyperiid amphipods are commonly found on *Chrysaora fuscescens*, *C. colorata*, *Aequorea* sp., *Phacellophora camtschatica, Aurelia aurita,* and *A. labiata***.** There may very well be other species that harbor these amphipods, especially if collecting is being done offshore. Members of the genus *Hyperoche* have also been associated with jellies, especially *H. medusarum* that parasitizes medusae and occasionally ctenophores. At one aquarium *C. gracilis* was allowed to be on *C. fuscescens* on display to eat hyperiid amphipods that might come in with the jellyfish. The crabs were removed when they reached a size that their legs might damage the soft jelly bells (C. Widmer, personal communication).

It has been proposed by Laval (1980) that nearly all hyperiids have evolved to utilize gelatinous zooplankton as a "pelagic substratum allowing the continuation of a benthic-like existence" similar to their gammarid relatives. The gelatinous zooplankton they associate with can be thought of as "islands in the ocean, providing sites of attachment, food, and shelter." This implies that nearly all hyperiids are parasites on gelatinous animals, for at least part, if not all of their lives. Some may be thought of as commensals, but it is likely that there is always some detrimental effect upon the jellies that they associate with. Hyperiids may eat prey items captured by the jelly, thus robbing the jelly of food; or, if food supply is not adequate, it may feed directly upon the jelly itself. Larvae and juveniles are often found embedded in the mesoglea, or in natural cavities of their host jelly. It is difficult to imagine any benefit to a jellyfish by harboring these amphipods.

When adult hyperiid amphipods are found on jellies, they can usually be physically removed rather easily with some blunt forceps, care being taken to not damage or injure the host jelly. Adults are often moving about freely upon the bell or on the sub-umbrellar surface, and are not attached to the jelly. They should be removed from the tank immediately. The host jelly should be re-examined frequently for several weeks, as sub-adult stages may have been missed upon the initial examinations and removal of the amphipods. Often more amphipods are noticed several weeks after the removal of all conspicuous adults. Jellies can usually recover from any damage caused by the amphipods if the infestation is not too heavy and if the situation is remedied immediately upon discovery.

Little is known about host specificity. Since some species such as *Hyperia galba* have been reported residing on a number of jelly hosts, it is assumed that these amphipods could infect species of jellies other than the ones initially found on. Hyperiids may be found free-living in tanks that had previously held parasitized jellies after the removal or death of those jellies. It is advised that tanks be well disinfected with chlorine after housing jellies known to be hosting hyperiid amphipods.

Crossley et al. (2010) found that the use of diflubenzuron (Dimilin) to eradicate hyperiid parasites from scyphomedusae was a safe and useful option when properly applied in a controlled environment. Boonstra et. al. (2015) used Milbemycin oxime (Interceptor) to treat adults of two jelly species*, (*pacific sea nettles, *C. fuscescens,* and egg yolk jellies*, Phacellophora camtschatica)* and juveniles of four Scyphozoan jellies (black sea nettles, *Chrysaora achlyos*; lion's mane jellies, *Cyanea capillata;* moon jellies, *Aurelia aurita; and* Japanese sea nettles, *Chrysaora pacifica*) as well as various sizes and life stages of the Hydrozoan *Eutonina indicans* (umbrella jelly). Treatment to eradicate the parasites was successful without adverse effects for all of the adult and juvenile jellies with the exception of the *Eutonina indicans* hydroids and smallest juveniles which suffered significant mortalities.

Jellyfish Disorders and Injuries

Physical deformities not associated with disease or parasites are often observed. Freeman et al. (2009) described characteristics of jellyfish eversion syndrome, a common occurrence observed by most jelly aquarists and that has been seen in many species of Scyphozoan jellies. Jellies that evert cannot pulse or swim properly and eventually lose the ability to gather and ingest food. Everted jellies will eventually shrink and die. The authors of the study used histologic examinations to characterize some of the degenerative changes observed in everted jellies. Additionally, a questionnaire related to jellyfish eversion syndrome was distributed to 87 AZA aquariums. Responses from 39 aquariums were analyzed. Unfortunately, there were no definitive conclusions as to the cause of jelly eversion; the authors describe it as a complex phenomenon, and most jelly aquarists would undoubtedly agree. Everted jellies rarely revert back to normal morphology and euthanasia is often required.

Another morphological deformity commonly observed are jellies that “ball up”, becoming very rounded and with weak or non-existent pulsing. Most experienced jelly aquarists would suggest a thorough tank cleaning, using chlorine. Flow rates and tank condition should also be evaluated. Another commonly observed condition is sometimes referred to in on-line forums as “lazy jelly syndrome”. The jellies will flatten out and stop pulsing, taking on a disc-like shape. Tank flow rates should be adjusted (usually reduced) in an attempt to stimulate pulsing. Personal experience has revealed that changing the flow or moving these jellies to another style of jelly tank will often improve the condition of these “lazy” jellies, and many will recover to normal or nearly normal shape and pulsing behavior.

Jellyfish Death, Euthanasia, and Necropsy

AZA-accredited zoos and aquariums provide superior daily care and husbandry routines, high quality diets, and regular veterinary care, to support jellyfish longevity. In the occurrence of death however, information obtained from necropsies is added to a database of information that assists researchers and veterinarians in zoos and aquariums to enhance the lives of jellyfish both in their care and in the wild. As stated in Chapter 7.3, necropsies should be conducted on deceased jellyfish to determine their cause of death, and the subsequent disposal of the body must be done in accordance with local, state, or federal laws (AZA Accreditation Standards 2.5.1 and 2.5.3). If the animal is on loan from another facility, the loan agreement should be consulted as to the owner’s wishes for disposition of the carcass; if nothing is stated, the owner should be consulted. Necropsies should include a detailed external and internal gross

AZA Accreditation Standard

(1.5.0) The institution must have a process for assessing animal welfare and wellness.

morphological examination and representative tissue samples from the body organs should be submitted for histopathological examination. Many institutions utilize private labs, partner with Universities or have their own in-house pathology department to analyze these samples. The AZA and American Association of Zoo Veterinarians (AAZV) website should be checked for any AZA Aquatic Invertebrate TAG-approved active research requests that could be filled from a necropsy.

The most humane euthanasia protocol for jellies is for them to be placed in an anesthesia bath of Tricaine mesylate, commercially known as MS-222. The most common cause of death in jellies in aquariums is senescence. Necropsy procedures are not defined for jellies. It is recommended that a general review of the morphology should be recorded.

Jellyfish Welfare and Wellness

AZA accredited institutions must have a clear and transparent process for assessing animal welfare and wellness, as well as for identifying and addressing jellyfish animal welfare concerns within the institution (AZA Accreditation Standards 1.5.0 and 1.5.8) and should have an established in-house, or institutional Animal Welfare Committee. This process should identify the protocols needed for animal care staff members to communicate animal welfare questions or concerns to their supervisors, the institution's Animal Welfare Committee or if necessary, the AZA Animal Welfare Committee. Protocols should be in place to document the training of staff about animal welfare issues, identification of any animal welfare issues, coordination and implementation of appropriate responses to these issues, evaluation (and adjustment of these responses if necessary) of the outcome of these responses, and the dissemination of the knowledge gained from these issues.

AZA Accreditation Standard

(1.5.8) The institution must develop and implement a clear and transparent process for identifying, communicating, and addressing animal welfare concerns from paid or unpaid staff within the institution in a timely manner, and without retribution.

There are no social or behavioral problems associated with jellies, as they do not possess a central nervous system. Jellyfish welfare is determined by observing locomotion and eating habits. If abnormal locomotion or eating habits are observed, steps should be taken to determine the cause. Once the cause is determined and fixed, staff should share their findings appropriately in their institution and to the larger community of jelly aquarists. Welfare concerns should be communicated to their Institutional Welfare Committee.

Chapter 8. Reproduction

8.1 Reproductive Physiology and Behavior

It is important to have a comprehensive understanding of the reproductive physiology and behaviors of the animals in our care. This knowledge facilitates all aspects of reproduction, artificial insemination, birthing, rearing, and even contraception efforts that AZA-accredited zoos and aquariums strive to achieve.

Cnidarian medusae have complex life cycles possessing several different life history forms, most of which are small. It is the largest of the stages, the medusa stage, which is most often displayed in public aquariums.

Members of the Class Scyphozoa possess a sessile, scyphistoma, or “polyp” stage that is inconspicuous, but it is this life stage that makes possible and practical the culture and propagation of jellies for aquarium exhibits. The polyp is typically 1–3 mm tall depending on the species, and groups of individual polyps make up populations of scyphistomae. Sexual reproduction does not occur in the benthic life history stages of jellyfish. Sessile polyps can spread asexually by generating other polyps, or they can give rise to the pelagic (medusa) stage by undergoing the asexual process of strobilation. The medusae are free-swimming and solitary. Most scyphomedusae become conspicuously large, although medusae belonging to the Class Hydrozoa tend to be smaller. With few exceptions, such as the compass jelly *Chrysaora hysoscella* which is a sequential protandric hermaphrodite, jellies are dioecious - They possess either male or female reproductive organs. The medusa stage of most species can only reproduce sexually, and in most species the fertilized egg eventually gives rise to a planula larva that settles and metamorphoses into a new sessile polyp. There are species in which the fertilized egg develops directly into another medusa, either exclusively (e.g., *Pelagia noctiluca*) or rarely (e.g., *Aurelia aurita*) (Arai, 1997).

Life Cycle of the Scyphozoa: The following section will describe the life cycle of typical semaestome and rhizostome scyphozoan medusae (see figure 1). Coronate jellies and stauromedusae are not typically exhibited by public aquariums and for the most part will not be discussed in detail. *A Functional Biology of Scyphozoa* by Mary N. Arai (1997) was used extensively as a guide to the descriptions of the scyphozoan life cycle.

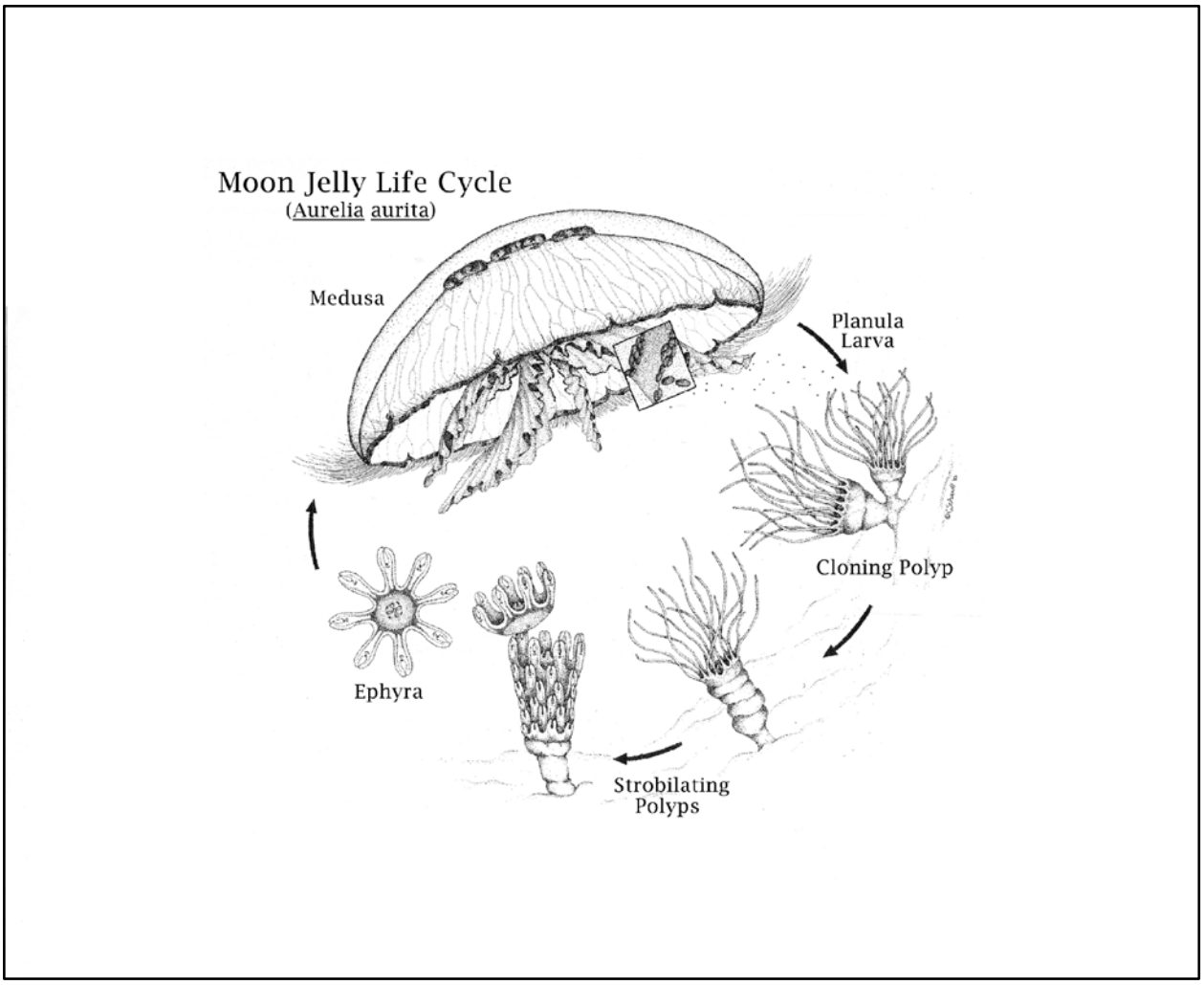

Figure 1: Moon jelly life cycle
Illustration courtesy of C. Schaadt

Polyp/Scyphistoma: The jelly polyp, or scyphistoma, resembles a small sea anemone (see figure 2). They are typically 1–2 mm in diameter and 2–3 mm tall, although some rhizostome polyps are smaller than 2 mm. The polyp is attached to a hard surface by a pedal disk. A tubular stalk leads to a ring of tentacles surrounding a central mouth. This oral disc containing the mouth and ring of tentacles is called the calyx. In the known polyps of jellies from the order Coronatae (e.g., *Linuche, Nausithoe*), there is a chitinous tube surrounding the stalk (Arai, 1997; Ortiz-Corp's, Cutress & Cutress, 1987); this is absent in polyps of the other orders.

The mouth leads to a blind pouch where food is digested, and waste is expelled back out through the mouth. During early development of the polyp, there are just two to four tentacles. This number increases as the polyp grows, and can increase to as many as 24 in some species. Uchida & Sugiura (1978) found as many as 40 tentacles in polyps of *Sanderia malayensis.* In nature, most polyps prefer to reside in a position where the tentacles can be suspended downward or sideways, rather than on horizontal surfaces. Brewer (1976) reports, "the scyphistoma is usually found suspended upside-down in a shaded location." This allows better extension of the tentacles and more efficiency in the capture of prey items, usually consisting of small zooplankton. It would also aid in preventing the polyp from being covered by silt or other debris (Cargo & Schultz, 1966), and provide an advantage when strobilation occurs and ephyrae are released (Brewer, 1976).

Polyps can spread asexually to form small populations; one way this is done is by budding. There are various means of budding, but in all cases, tissue generated by a parent polyp becomes detached from the

parent and gives rise to a new polyp. Usually these polyps are in very close proximity to the parent, but in several species of *Cassiopea* and in *Mastigias papua*, a ciliated planula-like bud, called a planuloid, is produced which can swim away and settle remotely, away from the parent (Van Lieshout & Martin, 1992; Sugiura, 1963). *Cotylorhiza tuberculata* are also capable of producing a planuloid bud (Arai, 1997).

In many, but not all species, polyps can also spread through the formation of podocysts. Arai (1997) defines podocysts as “cysts which form beneath the pedal disk of scyphistomae. They are surrounded by chitin.” These cysts are more or less dormant and can survive periods of unfavorable conditions. They are small, usually less than .5 mm in diameter and normally have a pale brown or yellowish color. Podocysts can remain viable for some time. Black et al. (1976) documented the survival of *Chrysaora quinquecirrha* podocysts for up to 25 months. Chapman (1968) mentions the ability of podocysts to survive for over 3 years. Some species commonly kept in aquarium cultures that can form podocysts are *Cyanea capillata*, *Aurelia aurita*, *A. labiata*, *Mastigias papua*, and most (if not all) species of *Chrysaora.*

Lesh-Laurie & Corriel (1973) reported that severed tentacles of *Aurelia aurita* polyps were able to regenerate entire polyps. This may not be a common means of asexual reproduction but should be noted as another potential reproductive factor.

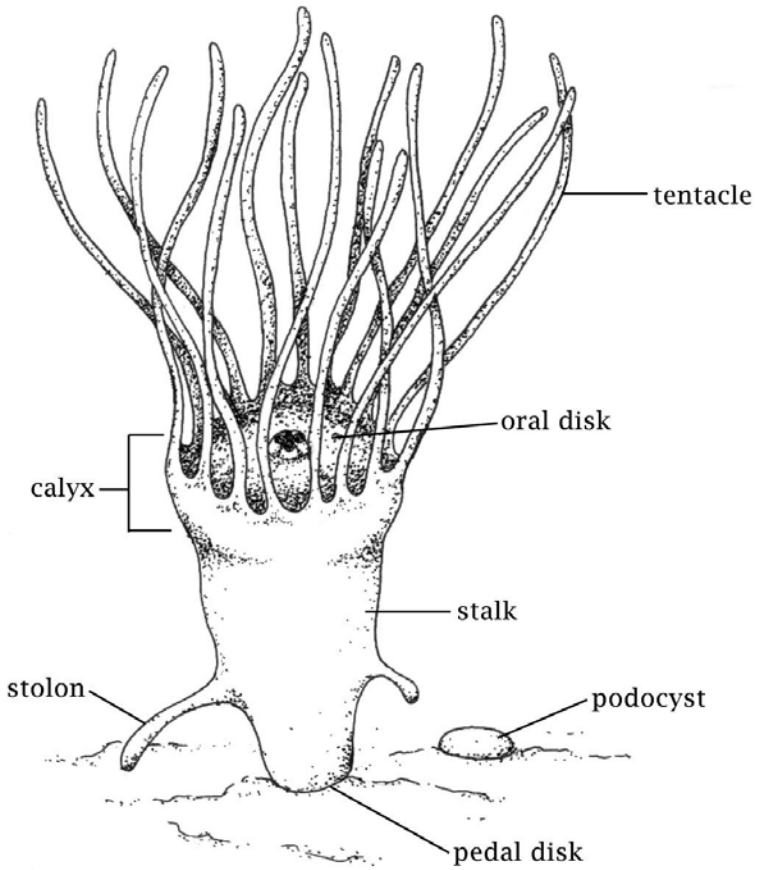

Figure 2: Polyp of scyphozoan medusa
Illustration courtesy of C. Schaadt

Strobilation: Strobilation is the process by which free-swimming ephyrae are generated and then liberated from polyps. According to Spangenberg (1968), it is actually two processes: segmentation and metamorphosis. At the onset of strobilation, the polyp often undergoes a color change. A constriction develops at the terminal end of a polyp to form a segment. As the constriction continues to develop, morphological changes occur. The tentacles of the polyp are resorbed. The outer margin of the polyp begins to convolute into bifurcated lobes. Each paired branch of the lobe is the marginal lappet of the developing ephyra. The constriction continues to develop until the terminal end is completely pinched off. At this time, the marginal lobes with a rhopalium at the junction between paired lappets are completely developed. The rhopalium is a sensory receptor used by ephyrae to determine orientation. This entire structure, which is now nearly segregated from the parent polyp, is called an ephyra. It begins to pulsate and ultimately breaks free from the polyp. The entire process of strobilation, from initiation of segmentation to release of the first ephyra, usually takes 3 to 5 days for some species of *Aurelia* and up to 12 weeks in other species for *Chrysaora* sp. Strobilation can continue to occur for several days to several weeks.

Strobilation can be monodisc, in which one ephyra at a time is generated, or polydisc, in which multiple ephyrae are generated. Most rhizostome jelly polyps, such as *Mastigias*, and *Cassiopea*, exhibit monodisc strobilation or polydisc strobilation with a relatively small number of developing ephyrae. Most of the Semaestome jellies commonly kept in culture (e.g., *Aurelia, Chrysaora, and Cyanea*) exhibit polydisc strobilation. There are typically 4–20 segments formed during polydisc strobilation, although there may be more. Gershwin & Collins (2002) observed 56 developing ephyrae on a strobilating polyp of *Chrysaora colorata.* The nutritive condition of the polyp (i.e. well-fed vs. starved) seems to play a role in the number of segments formed (Spangenberg, 1965a) with better fed strobilae producing more ephyrae than poorer fed ones.

Ephyrae and Juvenile Medusae: Ephyrae are the initial stage of the pelagic phase of a jelly's life, but they do not look like adult medusa (see figure 3). They are normally 1–2 mm in diameter just after strobilation, although some can be slightly larger. Most ephyrae have 8 marginal lobes, each with a pair of lappets. Some species (e.g., S*anderia malayensis)* have 16 marginal lobes, and often individuals with an irregular number of lobes will be found. A single gravity-sensing rhopalium lies between the lappets. Ephyrae can be clear, brown, or even red or maroon (e.g., *Chrysaora colorata*). As the ephyra grow (between 6–10 mm), the lobes begin to disappear, and they become more disc-like. Later, oral appendages begin to grow, the center thickens with mesoglea and the ephyra begins to "bell up," or take on more of the bell-shaped adult form. Eventually oral arms lengthen, and tentacles appear in species that have adult tentacles. At this point, the medusa can be considered a juvenile. It will look like a miniature version of an adult, although often the coloration and external markings are not the same as in the adult. The swimming behavior will be much the same as an adult of the species.

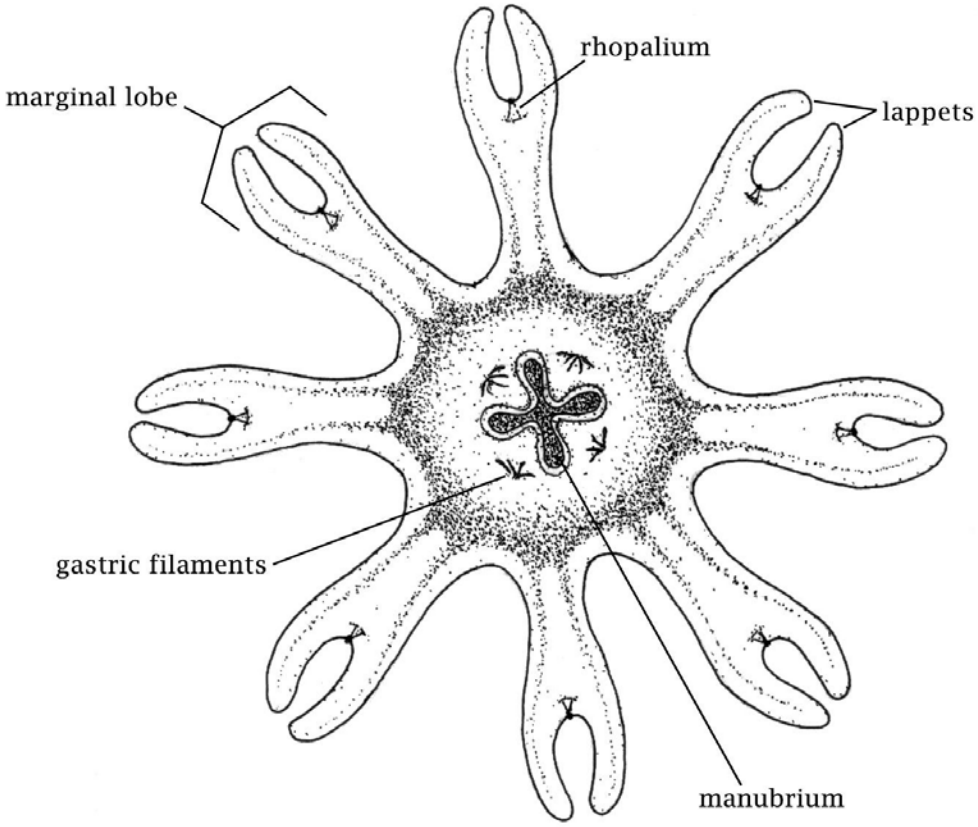

Figure 3: Ephyra of scyphozoan medusa
Illustration courtesy of C. Schaadt

Adult Medusa: Sexual reproduction occurs during the medusa stage (see figure 4). Most adult medusae are dioecious—that is, each medusa is either male or female. It is very difficult to tell males from females, although it may be possible in some species to distinguish between the sexes when gonads are mature, and samples of gonad tissue are examined under a dissecting microscope. Size is often the determining factor in maturation in the wild (Arai, 1997), although some species (e.g., *Cyanea*) will reach maturity even if they do not reach the large size usually associated with maturity (Brewer, 1989). In aquariums, medusae that would be considered too small in the wild to be mature will often become gravid.

Gonads in the Scyphozoa reside in the gastric pouches. A typical semaestome jelly will have four gastric pouches, each containing a horseshoe-shaped gonad. Mature sperm and eggs are released into the gastrovascular cavity and leave via the mouth into the seawater, where fertilization and embryo development take place. In *Aurelia*, sperm heads are embedded in thin strings that travel down channels in the oral arms and are released at the tip of each oral arm. Sperm may fertilize the eggs externally in seawater. In some jellies (e.g., *Aurelia aurita, A. labiata*, *Cotylorhiza tuberculata*, *Cyanea capillata*), the sperm is ingested. The eggs are fertilized within the gonad or genital sinus. These species brood the developing embryo and planula larvae in specialized brood pouches and release fully developed swimming planulae.

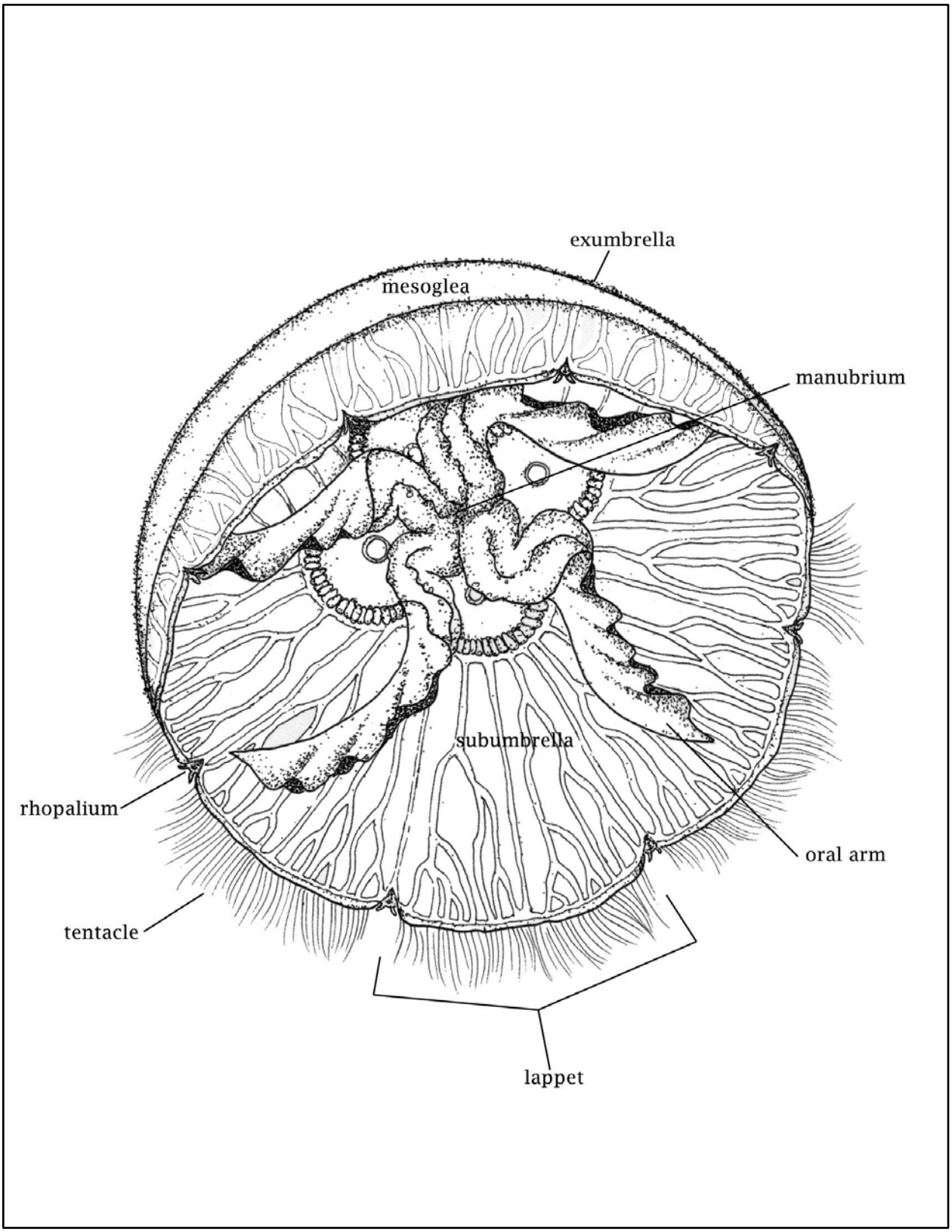

Figure 4: Adult scyphozoan medusa
Illustration courtesy of C. Schaadt

Planula: A fertilized egg begins to divide and develop into a ciliated planula larva within hours. The planula is described as "elongated and radially symmetrical, but with distinct anterior and posterior ends …there is neither a gastrovascular cavity nor a mouth" (Barnes, 1974). The cilia allow the planula to swim freely. Planula are usually oval or pear-shaped, 100–400 microns in length. They remain free-swimming, in search of a suitable substrate for attachment, for several hours up to 10 days (Arai, 1997). As previously noted, in *Aurelia*, the planula larvae develop and are held in specialized brood pouches, on the oral arms in *A. aurita*, or the manubrium in *A. labiata* (Gershwin, 2001) for a period of time before being released. In *Cyanea*, the planula are carried on the numerous oral folds found in this species.

In *Pelagia noctiluca,* the planula develops directly into an ephyra, rather than attaching and developing into a scyphistoma. Direct development of planulae to ephyrae has also been known to happen under rare circumstances in *Aurelia aurita* (Arai, 1997).

Planula Settlement: As stated above, planulae remain free swimming for several hours to several days. In some species, such as *Linuche unguiculata*, the planula may remain free-swimming for 3 to 4 weeks (Ortiz-Corp's, Cutress and Cutress, 1987). During the free-swimming stage, the planulae search for a suitable substrate to settle upon. The surface texture of the substrate can be a factor in determining whether or not a planula larva will choose to settle there. Planulae from a number of common coastal species (*Cyanea capillata,* and to a lesser extent, *Aurelia aurita* and *Chrysaora quinquecirrha)* exhibit a preference for rough surfaces or surfaces covered by organic and bacterial films vs. smooth surfaces (Brewer 1984; Cargo, 1979). Orientation in the water column is also an important factor. Polyps are often found in nature with their tentacles facing downward, so planulae seem to be selecting the sides or undersides of objects for settlement. Light levels may also be a factor, as many polyps found in the wild are found in shaded areas (Dolmer & Svane, 1993).

Once settled, the planula begins to develop into a polyp, or scyphistoma. The stalk begins to take form and the terminal end begins to thicken. The mouth and tentacles begin to develop. Under normal circumstances, and with the role of temperature kept in mind, within one week after settling a recognizable polyp with at least two tentacles is usually present. It will usually be weeks or months before the polyps begin to strobilate. However, Calder (1982) reported that polyps of *Stomolophus meleagris* began to strobilate nine days after settling and developing from planula larvae.

8.2 Artificial Insemination

The practical use of artificial insemination (AI) with animals was developed during the early 1900s to replicate desirable livestock characteristics in more progeny. Over the last decade or so, AZA-accredited zoos and aquariums have begun using AI processes more often with many of the animals residing in their care. AZA Studbooks are designed to help manage animal populations by providing detailed genetic and demographic analyses to promote genetic diversity with breeding pair decisions within and between our institutions. While these decisions are based upon sound biological reasoning, the efforts needed to ensure that transports and introductions are done properly to facilitate breeding between the animals are often quite complex, exhaustive, and expensive, and conception is not guaranteed.

AI has become an increasingly popular technology that is being used to meet the needs identified in the AZA Studbooks without having to relocate animals. Males are trained to voluntarily produce semen samples and females are being trained for voluntary insemination and pregnancy monitoring procedures such as blood and urine hormone measurements and ultrasound evaluations. Techniques used to preserve, and freeze semen have been achieved with a variety, but not all, taxa and should be investigated further.

In-vitro fertilization of jellies is now routine at most institutions and enhances the genetic diversity of their jellyfish culturing programs. Eggs are removed from ovaries and sperm from testes of dioecious species. Eggs and sperm are put into a Petri dish filled with clean seawater at appropriate temperature. Usually, in about 24 to 72 hours, free-swimming planula are observable under a microscope. The planulae can be removed to a Petri dish with clean seawater using a pipette. Over the next 24 to 72 hours many of the planula settle on the sides of the Petri dish and grow into scyphistomae (polyps). Some of the scyphistomae settle onto the surface of the seawater, hanging down into the water. These can be removed by placing a small plastic or glass plate into the surface where the scyphistomae are hanging. Most of the scyphistomae will attach themselves to the plate, which is then suspended in a small container of seawater. The developing scyphistomae are fed food appropriate for their size (e.g., rotifers or newly hatched enriched *Artemia*).

There have been attempts at cryopreservation of gametes of jellies with varying results. More work on this would be beneficial. Wild caught jellies are expensive and not reliably available from natural sources. Robust in-vitro and culturing efforts ensure jellies will be available to aquariums and zoos for exhibits.

8.3 Contraception

Many animals cared for in AZA-accredited institutions breed so successfully that contraception techniques are implemented to ensure that the population remains at a healthy size. In the case of an animal on loan from another facility, consult the loan agreement or owner regarding authority to contracept. In the case of permanent contraception, prior permission of the animal's owner must be obtained.

Most jellies produce massive numbers of both scyphistomae (polyps) and ephyrae (larval medusae). Those scyphistomae not used in culturing are typically considered fouling organisms and are cleaned from containers or aquaria. Successfully raising ephyrae to adult medusae is very difficult so efforts are usually focused on a relatively few of the ephyrae released. Surplus ephyrae are considered for sharing with other institutions or for food for medusivore jellies. The decision to produce or not produce new medusa is made based on the needs of the institution and its jellyfish exhibits.

Chapter 9. Ambassador Animals

9.1 Ambassador Animal Policy

AZA recognizes many public education and, ultimately, conservation benefits from ambassador animal presentations. AZA's Conservation Education Committee's Ambassador (previously called Program) Animal Position Statement (Appendix F) summarizes the value of ambassador animal presentations. For the purpose of this policy, an ambassador animal is described as an animal presented either within or outside of its normal exhibit or holding area that is intended to have regular proximity to or physical contact with trainers, handlers, the public, or will be part of an ongoing conservation education/outreach program.

Ambassador animal presentations bring a host of responsibilities, including the welfare of the animals involved, the safety of the animal handler and public, and accountability for the take-home, educational messages received by the audience. Therefore, AZA requires all accredited institutions that give ambassador animal presentations to develop an institutional ambassador animal policy that clearly identifies and justifies those species and individuals approved as ambassador animals and details their long-term management plan and educational program objectives. The policy must incorporate the elements contained in AZA's "Recommendations For Developing an Institutional Ambassador Animal Policy". If an animal on loan from another facility is used as an ambassador animal, the owner's permission is to be obtained prior to program use.

AZA's accreditation standards require that the conditions and treatment of animals in education programs must meet standards set for the remainder of the animal collection, including species-appropriate shelter, exercise, sound and environmental enrichment, access to veterinary care, nutrition, and other related standards (AZA Accreditation Standard 1.5.4). All record-keeping requirements noted previously apply to ambassador animals (AZA Accreditation Standards 1.4.1, 1.4.2, 1.4.3, 1.4.4, 1.4.5, 1.4.6, and 1.4.7). In addition, providing ambassador animals with options to choose among a variety of conditions within their environment is essential to ensuring effective care, welfare, and management (AZA Accreditation Standard 1.5.2.2). Some of these requirements can be met outside of the primary exhibit enclosure while the animal is involved in a program or is being transported. For example, housing may be reduced in size compared to a primary enclosure as long as the animal's physical and psychological needs are being met during the program; upon return to the facility the animal should be returned to its species-appropriate housing as described above.

AZA Accreditation Standard

(1.5.4) If ambassador animals are used, a written policy on the use of live animals in programs must be on file and incorporate the elements contained in AZA's "Recommendations For Developing an Institutional Ambassador Animal Policy" (see policy in the current edition of the *Accreditation Standards and Related Policies* booklet). An education, conservation, and welfare message must be an integral component of all programs. Animals in education programs must be maintained and cared for by paid and/or unpaid trained staff, and housing conditions must meet standards required for the remainder of the animals in the institution. While outside their primary enclosure, although the conditions may be different, animal safety and welfare need to be assured at all times.

Jellies, particularly *Aurelia*, are regularly used in an ambassador animal capacity. This includes the use of young medusae in small clear containers or jars to be used as an interactive resource, small life stages displayed interactively with the use of a microscope/video monitor, and increasingly aquariums are utilizing moon jelly touch exhibits or behind the scenes experiences. When jellies are used in this capacity, the institution should have written policies in place to protect the animals, staff, and guests from harm (AZA Accreditation Standard 1.5.4).

9.2 Institutional Ambassador Animal Plans

AZA's policy on the presentation of animals is as follows: AZA is dedicated to excellence in animal care and welfare, conservation, education, research, and the presentation of animals in ways that inspire respect for wildlife and nature. AZA's position is that animals should always be presented in adherence to the following core principles:

- Animal and human health, safety, and welfare are never compromised.
- Education and a meaningful conservation message are integral components of the presentation.
- The individual animals involved are consistently maintained in a manner that meets their social, physical, behavioral, and nutritional needs.

AZA-accredited institutions that have designated ambassador animals are required to develop their own Institutional Ambassador Animal Policy that articulates and evaluates the program benefits (see Appendix G for recommendations). Ambassador animals should be consistently maintained in a manner that meets their social, physical, behavioral, and nutritional needs. Education and conservation messaging must be an integral component of any ambassador animal demonstration (AZA Accreditation Standard 1.5.3).

AZA Accreditation Standard

(1.5.3) If animal demonstrations are a part of the institution's programs, an educational/conservation message must be an integral component.

Jellies used as ambassador animals allow for the interpreter or educator to discuss a variety of conservation related themes. The issue of ocean plastics (especially single use plastic shopping bags) is an excellent example. Small containers may compare living medusa to plastic waste which may confuse medusivores like the leatherback sea turtle. Interpreted exhibits in general allow for deeper interactions with the guests. This may be to simply answer questions about this intriguing animal group or to highlight several themes including blooms related to climate change, jellies impact on fisheries, jellies as invasive species, potential for a sustainable seafood source (certain rhizostomes), etc.

Animal care and education staff should be trained in ambassador animal-specific handling protocols, conservation, and education messaging techniques, and public interaction procedures. Paid and/or unpaid staff assigned to handle animals during demonstrations or educational programs must be trained in accordance with the institution's written animal handling protocols. Such training must take place before handling may occur (Accreditation Standard 1.5.12). These staff members should be competent in recognizing stress or discomfort behaviors exhibited by the ambassador animals and be able to address any safety issues that arise. Additionally, when in operation, animal contact areas must be supervised by trained paid and/or unpaid staff (AZA Accreditation Standard 1.5.13).

AZA Accreditation Standard

(1.5.12) Paid and/or unpaid staff assigned to handle animals during demonstrations or educational programs must be trained in accordance with the institution's written animal handling protocols. Such training must take place before handling may occur.

AZA Accreditation Standard

(1.5.13) When in operation, animal contact areas (petting zoos, touch tanks, etc.) must be supervised by trained, paid and/or unpaid staff.

Ambassador animals that are taken off zoo or aquarium grounds for any purpose have the potential to be exposed to infectious agents that could spread to the rest of the institution's healthy population. AZA-accredited institutions must have adequate protocols in place to avoid this (AZA Accreditation Standard 1.5.5).

When jellies are placed in clear containers the container should be small enough to remain lightweight so an interpreter may easily carry or hold to reduce the risk of dropping. Jellies should be of an appropriate size to comfortably fit within the container and bell freely. Acrylic containers are recommended over glass as lighter weight and may be less prone to crack or break. Lids should be designed to reduce or remove any air bubbles which may be ingested or captured under the bell. Staff trained to add or remove jellies into these containers should ensure the animals are transferred in water using gentle methods to protect the animals. The jellies may be kept in program containers for up to eight hours without food, but proper steps should be taken to maintain temperature. The temperature should not exceed more than three degrees Fahrenheit from the temperature of their enclosure. A redundant container may be rotated using a cooler to help regulate temperature especially with cold water jellies.

Similar precautions and training should be used while highlighting microscopic animals at interpretive stations. Polyps and ephyrae kept in small dishes should be rotated regularly to ensure access to food and proper temperatures especially if kept under intense light.

Moon jelly touch enclosures are a relatively new trend, but there have been positive results at multiple institutions. The delicate nature of jellies requires significant attention and guidance between the interpreter and the guests. It is advised the jellies are touched gently only on the tops of the bells to avoid poking, grabbing, or scratching. Moon jelly touch enclosures should only be made available to guests with a proportionally appropriate number of interpreters. The enclosure should remain closed to the public during times in which interpreters are not available.

Moon jelly stings are considered mild and may be viewed in a similar manner to cold water anemone touch enclosures. A hand washing station or hand sanitizer dispenser should be provided following the experience to wash away or disable potential residual nematocysts. Although there may be risk of allergic reaction, in over six years of operation, the Aquarium of the Pacific in Long Beach, California has had

hellzero reported negative reactions during a time in which experience was made available to over 9 million visitors.

Careful consideration must be given to the design and size of all ambassador animal enclosures, including exhibit, off-exhibit holding, hospital, quarantine, and isolation areas, such that the physical, social, behavioral, and psychological needs of the species are met and species-appropriate behaviors are facilitated (AZA Accreditation Standard 10.3.3, 1.5.2, 1.5.2.1).

Similar consideration needs to be given to the means in which an animal will be transported both within the Institution's grounds, and to/from an off-grounds program. Animal transportation must be conducted in a manner that is lawful, safe, well planned, and coordinated, and minimizes risk to the animal(s), employees, and general public (AZA Accreditation Standard 1.5.11).

Jelly containers for program activities should be clean, smooth, and free of debris. The lids should be secure and preferably not hollow which may hold air pockets that could injure the jellies. The size should appropriately match the intended size of jellies, and should be light enough for safe transport and carry.

Enclosures for moon jelly touch exhibits should meet all standards for proper jelly husbandry. Gentle water currents should move jellies across appropriately sized screens or barriers to avoid jellies suctioned to outflows. The tanks should be kept clean and well lit. Water quality conditions should be pristine and tested regularly. The filtration system should adequately sterilize the water to protect both the animals and the guests from harmful bacteria. Ultraviolet sterilizers are recommended over injected ozone to minimize the risk of small bubbles damaging jelly tissues. Temperature control should keep the water at plus or minus 2 degrees Fahrenheit from the set point. The jellies should be stocked appropriately to minimize repetitive touches of only a few individuals. For this reason, higher stocking densities are recommended up to approximately one ~6-inch moon jelly per gallon which may depend on the quantity of encounters. For this reason, those considering this type of exhibit should have a regular supply of animals or have the ability to aquaculture an appropriate number of jellies. A recovery tank may be helpful for jellies with minor damage, although stock rotation may not be necessary if all of the above policies are followed.

Similar consideration needs to be given to the means in which an animal will be transported both within the Institution's grounds, and to/from an off-grounds program. Animal transportation must be conducted in a manner that is lawful, safe, well planned, and coordinated, and minimizes risk to the animal(s), employees, and general public (AZA Accreditation Standard 1.5.11).

9.3 Program Evaluation

AZA-accredited institutions that have an Institutional Ambassador Animal Plan are required to evaluate the efficacy of the plan routinely (see Appendix G for recommendations). Education and conservation messaging content retention, animal health and well-being, guest responses, policy effectiveness, and accountability and ramifications of policy violations should be assessed and revised as needed.

Ambassador Animal Plan for jellyfish should be reviewed every year and thoroughly reviewed at least every five years. Incident reports should be filled out by program staff involved; any incident reports that include violations of the Plan should be immediately investigated by the institution's Animal Welfare Committee, or in the case of guest or staff safety involvement, the institutional Safety Committee. Violations deemed by the institutional Animal Welfare Committee or Safety Committee as serious (jeopardizing the safety of visitors/staff or the welfare of the jellyfish) may result in consequences such as staff retraining or revocation of handling privileges.

It is recommended that staff should collect visitor responses at the conclusion of the program. Once compiled, these responses should be used to inform program improvements.

Chapter 10. Research

10.1 Known Methodologies

AZA believes that contemporary jellyfish management, husbandry, veterinary care and conservation practices should be based in science, and that a commitment to scientific research, both basic and applied, is a trademark of the modern zoological park and aquarium. AZA-accredited institutions have the invaluable opportunity, and are expected, to conduct or facilitate research in both *in situ* and *ex situ* settings to advance scientific knowledge of the animals in our care and enhance the conservation of wild populations. Participating in AZA Taxon Advisory Group (TAG) or Species Survival Plan® (SSP) Program sponsored research when applicable, conducting and publishing original research projects, affiliating with local universities, and/or employing staff with scientific credentials could help achieve this (AZA Accreditation Standard 5.3). An AZA institution must demonstrate a commitment to scientific study that is in proportion to the size and scope of its facilities, staff, and animals (AZA Accreditation Standard 5.0).

AZA Accreditation Standard

(5.3) The institution should maximize the generation and dissemination of scientific knowledge gained. This might be achieved by participating in AZA TAG/SSP sponsored studies when applicable, conducting and publishing original research projects, affiliating with local universities, and/or employing staff with scientific credentials.

AZA Accreditation Standard

(5.0) The institution must have a demonstrated commitment to scientific study that is in proportion to the size and scope of its facilities, staff (paid and unpaid), and animals.

All record-keeping requirements noted previously apply to most research animals, especially those which are part of the exhibit collection. When an animal on loan to a facility is subject to an invasive research procedure, including when done as part of a routine health exam, the owner's prior permission is to be obtained.

Research and conservation initiatives for jellies are varied and certainly change from different regions of the US and the world. Some examples in Southern California for research include: neuroscience (UCLA), cell biology, biomechanics, and applications to engineering (California Institute of Technology), and taxonomy and biogeographics (UC Berkeley). The most important conservation research issues are jellyfish blooms and jellies as invasive species. Institutions that have opportunities to conduct or otherwise support research on jellies should do so.

Research investigations, whether observational, behavioral, physiological, or genetically based, should have a clear scientific purpose with the reasonable expectation that they will increase our understanding of the species being investigated and may provide results which benefit the health or welfare of animals in wild populations. Many AZA-accredited institutions incorporate superior positive reinforcement training programs into their routine schedules to facilitate sensory, cognitive, and physiological research investigations and these types of programs are strongly encouraged by the AZA, however this taxa not being in possession of a central nervous system is typically found to be a major impediment to such studies. Typically animals without brains are difficult subjects in cognitive research.

AZA Accreditation Standard

(5.2) The institution must follow a formal written policy that includes a process for the evaluation and approval of scientific project proposals, and outlines the type of studies it conducts, methods, staff (paid and unpaid) involvement, evaluations, animals that may be involved, and guidelines for publication of findings.

AZA Accreditation Standard

(5.1) Scientific studies must be under the direction of a paid or unpaid staff member or committee qualified to make informed decisions.

AZA-accredited institutions are required to follow a clearly written research policy that includes a process for the evaluation of project proposals and identifies the types of research being conducted, methods used, staff involved, evaluations of the projects, animals included, and guidelines for the reporting or publication of any findings (AZA Accreditation Standard 5.2). Institutions must designate a qualified staff member or committee to oversee and direct its research program (AZA Accreditation Standard 5.1).

An Institutional Animal Care and Use Committee (IACUC) should be established within the institution if animals are included in research or instructional programs. The IACUC should be responsible for reviewing all research protocols and conducting evaluations of the institution's animal care and use.

If institutions are not able to conduct in-house research investigations, they are strongly encouraged to provide financial, personnel, logistical, and other support for priority research and conservation initiatives identified by Taxon Advisory Groups (TAGs) or Species Survival Plans® (SSP) Programs.

10.2 Future Research Needs

This Animal Care Manual is a dynamic document that will need to be updated as new information is acquired. Knowledge gaps have been identified throughout the Manual and are included in this section to promote future research investigations. Knowledge gained from these areas will maximize AZA-accredited institutions' capacity for excellence in animal care and welfare as well as enhance conservation initiatives for the species.

The husbandry and public display of jellies is still a relatively young discipline having begun on a large scale in Japan in the 1960s and not in a serious way until the 1990s in the United States. Nutrition, culturing, husbandry, and display issues are regularly being improved upon.

There is still much to learn about diseases of jellyfish. Often the aquarist will feel helpless when observing the deteriorating condition of specimens in his/her care. At the present time, little is known to be of clear value in the treatment of most jelly diseases or problems. Providing the best nutrition, water quality, cleanliness, tank flow conditions, etc. is the best guarantee for preventing diseases or undesirable jellyfish conditions such as eversions or bell rot. Jellies in the wild do not normally live very long; most survive 1 year or less. It is likely there is little that can be done once a jelly begins to senesce. Without more laboratory research, the answers won't be known.

There will likely be more discoveries of parasitic associations between jellyfish and other invertebrates. Progress has been made in recent years discovering safe treatments for the eradication of crustacean parasites. More work replicating these treatments will provide greater confidence in the use of these drugs and reveal potential deleterious effects on specific jelly species or sensitivities at early life stages.

The problem of jellyfish eversions is a common one in jelly culture and husbandry, yet very little is known about the cause. Freeman et al. (2009) studied this syndrome and concluded that it is a complex phenomenon associated with degenerative changes of the bell matrix. However, the causes of this and similar problems in which jellies become deformed or develop irregular morphologies are not yet known.

Nutrition for jellies in human care is covered in Chapter 5. As mentioned in that chapter "the scientific literature includes little information on species specific nutrient requirements". *Ex situ* nutritional studies for jellies in human care would benefit the husbandry community. Jellyfish will ingest a variety of food items, but little is known regarding which items would supply the best nutritional profile for jellyfish growth and health. Most aquarists use supplements to enrich the *Artemia* nauplii that are by far the most common and important food source for jellies in aquariums. There are multiple possibilities for supplementing but little is known about the best nutritional supplements pertaining to the growth and overall health of jellyfish. Most of these supplements are specifically designed to be used for the aquaculture of fishes.

Lighting used with managed jellyfish that host zooxanthellae would also be a valuable topic for research. *In situ* studies have found that photosynthesis can provide most if not all of the metabolic carbon demand for photosynthetic jellies such as *Mastigias* and *Cassiopea* (McClosky et.al.,1984, Verde and McCloskey,1998). Using the best lighting parameters for these jellies in aquariums should result in better health, growth rates and longevity.

AZA institutions should continue to support research and conservation efforts as their resources allow. Scientists can benefit by collaborating with jellyfish husbandry experts and those that culture jellyfish. Providing cultured specimens and husbandry expertise can be very beneficial to researchers performing laboratory studies on jellies. One major conservation concern is the phenomenon of jellyfish blooms in the wild. Many researchers all around the world are working on this issue (Mills, 2001; Purcell et al., 2001; Purcell et al., 2007). Global warming and the changing ocean environment (i.e. acidification, overfishing) are other concerns, as these could have implications for jellyfish populations, blooms, expansion or contraction of geographical ranges, etc. (Richardson, et. al., 2009, Gibbons and Richardson, 2013). AZA institutions should share messaging about jellyfish blooms in their jellyfish exhibits and programs and take advantage of collaborating with scientists working to understand this issue. Institutions can further enhance the sustainability of their collections by improving culturing efforts and increasing support for jellyfish related research.

Chapter 11. Other Considerations

11.1 Surplus Animals

All SSP species held by institutions should be reported to the SSP Program Leaders. The SSP Program Leader should be responsible for making the decision as to whether or not specific animals are to be included in the managed population (e.g., over-represented animals or animals beyond reproductive age). Those animals not included in the managed population should be considered surplus to the managed population, but records still must be maintained on them to the same degree as those in the managed population.

There are currently no jellyfish that are managed by an SSP program. Aquariums and zoos often share surplus jellyfish with other institutions following institutional population management programs.

11.2 Additional Information

A story is told that back in the 1950s and 60s an aquarium wanted to display adult medusae of the purple striped jellyfish (*Chrysaora colorata*). No tank was found that would enable the 40cm wide purple striped jellies to swim let alone survive for more than a couple days. So aquarists threaded a needle with a monofilament line that terminated in a large button up through the manubrium which suspended the jellies in a tank. As the jellies belled and eventually relaxed, they would stay suspended for people to see. Attempts at feeding the jellies were unsuccessful and the technique resulted in the disintegration of the bell over just a few days.

In the 1980s, Monterey Bay Aquarium (MBA) had a small exhibit of live moon jellies that seemed to catch the imagination of visitors (Powell, 2001). MBA already had a good relationship with aquariums in Japan. Yoshitaka Abe from the Ueno Aquarium and Kazuko Shimura from the Enoshima Aquarium worked with MBA staffers Dave Powell and Freya Summer to share successful jellyfish husbandry and display techniques (Powell, 2001). Mr. Abe had extensive experience raising moon jellyfish (Abe, 1969) and Ms. Shimura had experience raising many other jellies. Ms. Summer became singularly successful at raising jellyfish and gave a paper at the Western Regional Conference of the American Association of Zoological Parks and Aquariums (AAZPA now Association of Zoos and Aquariums (AZA)) in Tacoma, WA (Sommer, 1986) which is still one of the best overviews of culturing moon jellies. Ms. Summer expanded her interest to include other species and was soon culturing all sorts of jellies at MBA. One of her projects turned out to be a significant contribution to science as she discovered that the purple striped jelly had a scyphistoma stage, something the literature of the day said was not part of its life history. This eventually resulted in a publication describing the reproduction in the purple striped jelly and assigning it to the genus *Chrysaora* (from *Pelagia*) (Gershwin & Collins, 2002).

As Ms. Summer's work continued to expand the husbandry of heretofore undisplayed jellies, there was a push to make an exhibit that would allow visitors to see these little-known creatures. Despite some reservations that jellies were not interesting enough to visitors, the MBA opened the "Planet of the Jellies" in 1992. This exhibit became the most successful temporary exhibit MBA had ever presented and was critically acclaimed by all. Other MBA staff who worked closely with this project included Bruce Upton, Mark Ferguson and Dave Wrobel. In 2003, MBA opened another very successful special exhibition featuring jellyfish called "Jellies: Living Art."

One of the advances in the successful display of jellies was the development of tank designs that simulated their planktonic environment. In 1897 while studying jellyfish at Plymouth, England E.T Browne noted that jellyfish would sit on the bottom and soon die in a laboratory aquarium unless they were moved around by some type of current (Browne, 1897). He developed "the plunger jar" comprised of an auto-siphoning can on one side of a fulcrum, and a lever with a plate extended into a seawater filled jar and jellyfish on the other. He used the plunger jar to rear a large variety of small jellyfish, and other researchers used it to raise larval fish and invertebrates. It makes a fine gentle surge device for small aquariums (Widmer, personal communication). In Germany in the 1960's, Wolf Greve was studying ctenophores and chaetognaths. He developed a tank he called a planktonkreisel referring to the tank's circular design that helped keep plankton suspended so he could study them (Greve, 1968). In 1975, Greve further modified his planktonkreisel to improve viewing for behavioral studies and called his new design the meteor planktonkuvette (Greve, 1975). Hamner (1990) working with the staff of MBA, further refined Greve's design to come up with a shipboard version he also called a planktonkreisel for studying plankton freshly caught from a ship at sea. Hamner's design also made for a great way to see planktonic organisms swimming in

gentle currents. Many planktonkreisels were incorporated into the "Planet of the Jellies" exhibit. Planktonkreisels and the similar pseudokreisels became the basic design used by many aquariums and zoos to display jellyfish and other gelatinous zooplankton (e.g., ctenophores).

In Europe, Paul Van Den Sande at the Antwerp Zoo Aquarium in Belgium and Jurgen Lange at the Berlin Zoo in Germany led the way in culturing jellies (Lange, 1995). In the early 1990s a few aquariums opened special exhibitions of jellies. The reaction from the public led to many of these exhibitions traveling to other aquariums in the country.

As more and more aquariums and zoos wanted to either acquire jelly exhibits or expand their species list, attempts were made to gather people together to share information. In 1998, Mike Schaadt organized a jelly husbandry workshop at the Western Regional Meeting of the AZA in Monterey, CA, it was passed to Libby Nickels at the Florida Aquarium in 2019. The Jelly Directory was the result of that meeting where staff working on jellyfish at aquariums and zoos would supply their contact information, the species of jellies they culture and display and the types of tanks they use. Anyone on the list can get an updated list by contacting Libby Nickels (lnickels@flaquarium.org). In 2003, the Jellyfish listserv was started under the website of AZA. There was also a session given at the 2005 Annual Conference of AZA in Chicago, IL, which was the beginning of the Jellyfish Care Manual. Also during the Chicago meeting in 2005, Chad Widmer first presented on the idea of the need for an AZA jellyfish husbandry school due to the high volume of questions he received on the subject during his tenure at MBA. He presented on the same subject again at the Regional Aquatic Workshop held at Newport, KY in 2010 but the timing for the idea was not yet right. In 2011, the British and Irish Association of Zoos and Aquariums and then PhD student Widmer held a week-long course hosted by the National Aquarium in Plymouth on the husbandry of jellyfish that was very well attended.

Since 2015, Monterey Bay Aquarium has been offering Jelly School a 2.5-day workshop focused on public aquarium jelly husbandry. The course is led by Monterey Bay Aquarium's jelly team and focuses on all things jelly husbandry: primary care, exhibitry, collection and acquisition, captive culture and more.

The Role of the Aquarist in Collecting Data

Some of the most useful science aquarists are well situated for conducting today are experiments on the ways that environmental variables affect asexual reproductive output of jellyfish scyphistomae and hydroid colonies. The results of such studies will provide useful information on the ways that global jellyfish population abundances in the wild may be affected by climate change because whether or not polyps produce medusae is greatly influenced by environmental variables such as temperature, salinity and pH (Lucas et al. 2012). For aquarists interested in conducting such studies Dr. Chad Widmer is keen to collaborate and can be reached at chad.widmer@pdza.org.

Aquarists should also endeavor to establish collaborative working relationships with members of the international research community. It is often the case that aquarists are not properly trained researchers, and researchers are not very good aquarists. When the two groups work together both can accomplish and create a great deal more than either can alone. For example, researchers may not have access to sea water, food, electricity, staff, time etc. but aquarists do. Aquarists may not have access to ocean going research vessels and remotely operated vehicles which allows them to collect potentially new display species. When aquarists go to sea everyone benefits.

Aquarists have a unique opportunity to document species in known geographic locations. Coastal aquarists and aquarists collecting their own specimens can observe species in the wild and document newly introduced species. It is important to describe seasonal occurrence, new geographic locations, and new records for collected specimens.

It is the responsibility of the aquarist to ensure that no form of the jelly life cycle (planula, polyp, or medusa) is released into non-native waters. Many species can rapidly proliferate into a new environment. The cases of the plant *Caulerpa* in the Mediterranean, the scyphozoan *Phyllorhiza* in Southern California with its spread into the Gulf of Mexico and the ctenophore *Mnemiopsis* in the Black Sea serve as good lessons for both an accidental aquarium release and invasive species spread into new geographic locations.

It is clear that gelatinous plankton speciation is much more complex than the current 200 species of Scyphozoa (Mianzan & Cornelius, 1999) and perhaps over 3,000 species of Hydrozoa (Schuchert, 1998) reveal. Molecular genetics can provide taxonomic verification, differentiate cryptogenic species, identify source populations and assess the extent and impact of invasive species (Dawson et al., 2005). Genetics

coupled with detailed morphological assessment is the best method to access the speciation of gelatinous plankton.

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http://www.lifesci.ucsb.edu/~biolum/ – Bioluminescence and a lot more about gelatinous zooplankton.
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https://jellybiologist.com/ - Jellyfish and Marine Invertebrate blog by Dr. Rebecca Helm.

Appendix A: Accreditation Standards by Chapter

The following specific standards of care relevant to jellyfish are taken from the AZA Accreditation Standards and Related Policies (AZA, 2017) and are referenced fully within the chapters of this animal care manual:

General Information

(1.1.1) The institution must comply with all relevant local, state/provincial, and federal wildlife laws and/or regulations. It is understood that, in some cases, AZA accreditation standards are more stringent than existing laws and/or regulations. In these cases the AZA standard must be met.

Chapter 1

(1.5.7) The animals must be protected or provided accommodation from weather or other conditions clearly known to be detrimental to their health or welfare.

(10.2.1) Critical life-support systems for the animals, including but not limited to plumbing, heating, cooling, aeration, and filtration, must be equipped with a warning mechanism, and emergency backup systems must be available. Warning mechanisms and emergency backup systems must be tested periodically.

(1.5.9) The institution must have a regular program of monitoring water quality for fish, marine mammals, and other aquatic animals. A written record must be maintained to document long-term water quality results and chemical additions.

Chapter 2

(1.5.1) All animals must be well cared for and presented in a manner reflecting modern zoological practices in exhibit design, balancing animals' welfare requirements with aesthetic and educational considerations.

(1.5.2) All animals must be housed in enclosures which are safe for the animals and meet their physical and psychological needs.

(1.5.2.1) All animals must be kept in appropriate groupings which meet their social and welfare needs.

(1.5.2.2) All animals should be provided the opportunity to choose among a variety of conditions within their environment.

(10.3.3) All animal enclosures (exhibits, holding areas, hospital, and quarantine/isolation) must be of a size and complexity sufficient to provide for the animal's physical, social, and psychological well-being. AZA housing guidelines outlined in the Animal Care Manuals should be followed.

(10.3.4) When sunlight is likely to cause overheating of or discomfort to the animals, sufficient shade (in addition to shelter structures) must be provided by natural or artificial means to allow all animals kept outdoors to protect themselves from direct sunlight.

(11.3.3) Special attention must be given to free-ranging animals so that no undue threat is posed to either the institution's animals, the free-ranging animals, or the visiting public. Animals maintained where they will be in contact with the visiting public must be carefully monitored, and treated humanely at all times.

(11.3.1) All animal exhibits and holding areas must be secured to prevent unintentional animal egress.

(1.5.15) All animal exhibit and holding area air and water inflows and outflows must be securely protected to prevent animal injury or egress.

(2.8.1) Pest control management programs must be administered in such a manner that the animals, paid and unpaid staff, the public, and wildlife are not threatened by the pests, contamination from pests, or the control methods used.

(11.3.6) There must be barriers in place (for example, guardrails, fences, walls, etc.) of sufficient strength and/or design to deter public entry into animal exhibits or holding areas, and to deter public contact with animals in all areas where such contact is not intended.

(11.2.4) All emergency procedures must be written and provided to appropriate paid and unpaid staff. Appropriate emergency procedures must be readily available for reference in the event of an actual emergency.

(11.2.5) Live-action emergency drills (functional exercises) must be conducted at least once annually for each of the four basic types of emergency (fire; weather or other environmental emergency appropriate to the region; injury to visitor or paid/unpaid staff; and animal escape). Four separate drills are required. These drills must be recorded and results evaluated for compliance with emergency procedures, efficacy of paid/unpaid staff training, aspects of the emergency response that are deemed adequate are reinforced, and those requiring improvement are identified and modified. (See 11.5.2 and 11.7.4 for other required drills).

(11.6.2) Security personnel, whether employed by the institution, or a provided and/or contracted service, must be trained to handle all emergencies in full accordance with the policies and procedures of the institution. In some cases, it is recognized that Security personnel may be in charge of the respective emergency (i.e. shooting teams).

(11.2.6) The institution must have a communication system that can be quickly accessed in case of an emergency.

(11.2.0) A paid staff member or a committee must be designated as responsible for ensuring that all required emergency drills are conducted, recorded, and evaluated in accordance with AZA accreditation standards (see 11.2.5, 11.5.2, and 11.7.4).

(11.2.7) A written protocol should be developed involving local police or other emergency agencies and include response times to emergencies.

(11.5.3) Institutions maintaining potentially dangerous animals must have appropriate safety procedures in place to prevent attacks and injuries by these animals. Appropriate response procedures must also be in place to deal with an attack resulting in an injury. These procedures must be practiced routinely per the emergency drill requirements contained in these standards. Whenever injuries result from these incidents, a written account outlining the cause of the incident, how the injury was handled, and a description of any resulting changes to either the safety procedures or the physical facility must be prepared and maintained for five years from the date of the incident.

(11.5.2) All areas housing venomous animals must be equipped with appropriate alarm systems, and/or have protocols and procedures in place which will notify paid and unpaid staff in the event of a bite injury, attack, or escape from the enclosure. These systems and/or protocols and procedures must be routinely checked to insure proper functionality, and periodic drills (at minimum annually) must be conducted to insure that appropriate paid and unpaid staff are notified (See 11.2.5 and 11.7.4 for other required drills).

(11.5.1) Institutions maintaining venomous animals must have appropriate antivenin readily available, and its location must be known by all paid and unpaid staff working in those areas. An individual must be responsible for inventory, disposal/replacement, and storage of antivenin.

Chapter 3

(1.4.0) The institution must show evidence of having a zoological records management program for managing animal records, veterinary records, and other relevant information.

(1.4.6) A paid staff member must be designated as being responsible for the institution's animal record-keeping system. That person must be charged with establishing and maintaining the institution's animal records, as well as with keeping all paid and unpaid animal care staff members apprised of relevant laws and regulations regarding the institution's animals.

(1.4.7) Animal and veterinary records must be kept current.

(1.4.4) Animal records, whether in electronic or paper form, must be duplicated and stored in a separate location. Animal records are defined as data, regardless of physical form or medium, providing information about individual animals, or samples or parts thereof, or groups of animals.

(1.4.5) At least one set of the institution’s historical animal and veterinary records must be stored and protected. Those records should include permits, titles, declaration forms, and other pertinent information.

(1.4.1) An animal inventory must be compiled at least once a year and include data regarding acquisition, transfer, euthanasia, release, and reintroduction.

(1.4.2) All species owned by the institution must be listed on the inventory, including those animals on loan to and from the institution.

(1.4.3) Animals must be identifiable, whenever practical, and have corresponding ID numbers. For animals maintained in colonies/groups or other animals not considered readily identifiable, the institution must provide a statement explaining how record keeping is maintained.

Chapter 4

(1.5.11) Animal transportation must be conducted in a manner that is safe, well-planned and coordinated, and minimizes risk to the animal(s), employees, and general public. All applicable laws and/or regulations must be adhered to.

(1.5.10) Temporary, seasonal and traveling live animal exhibits, programs, or presentations (regardless of ownership or contractual arrangements) must be maintained at the same level of care as the institution's permanent resident animals, with foremost attention to animal welfare considerations, both onsite and at the location where the animals are permanently housed.

Chapter 6

(2.6.2) The institution must follow a written nutrition program that meets the behavioral and nutritional needs of all species, individuals, and colonies/groups in the institution. Animal diets must be of a quality and quantity suitable for each animal's nutritional and psychological needs.

(2.6.1) Animal food preparation and storage must meet all applicable laws and/or regulations.

(2.6.3) The institution must assign at least one paid or unpaid staff member to oversee appropriate browse material for the animals (including aquatic animals).

Chapter 7

(2.1.1) A full-time staff veterinarian is recommended. In cases where such is not necessary because of the number and/or nature of the animals residing there, a consulting/part-time veterinarian must be under written contract to make at least twice monthly inspections of the animals and to respond as soon as possible to any emergencies.

(2.1.2) So that indications of disease, injury, or stress may be dealt with promptly, veterinary coverage must be available to the animals24 hours a day, 7 days a week.

(2.0.1) The institution should adopt the *Guidelines for Zoo and Aquarium Veterinary Medical Programs and Veterinary Hospitals,* and policies developed or supported by the American Association of Zoo Veterinarians (AAZV). The most recent edition of the medical programs and hospitals booklet is available at the AAZV website, under "Publications", at https://cdn.ymaws.com/www.aazv.org/resource/resmgr/files/aazvveterinaryguidelines2016.pdf, and can also be obtained in PDF format by contacting AZA staff.

(2.2.1) Written, formal procedures must be available to paid and unpaid animal care staff for the use of animal drugs for veterinary purposes, and appropriate security of the drugs must be provided.

(2.7.1) The institution must have holding facilities or procedures for the quarantine of newly arrived animals and isolation facilities or procedures for the treatment of sick/injured animals. Quarantine duration should be assessed and determined by the pathogen risk and best practice for animal welfare.

(2.7.3) Quarantine, hospital, and isolation areas should be in compliance with standards/guidelines contained within the *Guidelines for Zoo and Aquarium Veterinary Medical Programs and Veterinary Hospitals* developed by the American Association of Zoo Veterinarians (AAZV), which can be obtained at: https://cdn.ymaws.com/www.aazv.org/resource/resmgr/files/aazvveterinaryguidelines2016.pdf.

(2.7.2) Written, formal procedures for quarantine must be available and familiar to all paid and unpaid staff working with quarantined animals.

(11.1.2) Training and procedures must be in place regarding zoonotic diseases.

(2.5.1) Deceased animals should be necropsied to determine the cause of death for tracking morbidity and mortality trends to strengthen the program of veterinary care and meet SSP-related requests.

(2.5.2) The institution should have an area dedicated to performing necropsies.

(2.5.3) Cadavers must be kept in a dedicated storage area before and after necropsy. Remains must be disposed of in accordance with local/federal laws.

(2.0.2) The veterinary care program must emphasize disease prevention.

(2.0.3) Institutions should be aware of and prepared for periodic disease outbreaks in wild or other domestic or exotic animal populations that might affect the institution's animals (ex – Avian Influenza, Eastern Equine Encephalitis Virus, etc.). Plans should be developed that outline steps to be taken to protect the institution's animals in these situations.

(1.5.5) For animals used in offsite programs and for educational purposes, the institution must have adequate protocols in place to protect the rest of the animals at the institution from exposure to infectious agents.

(11.1.3) A tuberculin (TB) testing/surveillance program must be established for appropriate paid and unpaid staff in order to assure the health of both the paid and unpaid staff and the animals.

(2.3.1) Capture equipment must be in good working order and available to authorized, trained personnel at all times.

(2.1.3) Paid and unpaid animal care staff should be trained to assess welfare and recognize abnormal behavior and clinical signs of illness and have knowledge of the diets, husbandry (including enrichment items and strategies), and restraint procedures required for the animals under their care. However, animal care staff (paid and unpaid) must not diagnose illnesses nor prescribe treatment.

(2.3.2) Institution facilities must have radiographic equipment or have access to radiographic services.

(1.5.0) The institution must have a process for assessing animal welfare and wellness.

(1.5.8) The institution must develop and implement a clear and transparent process for identifying, communicating, and addressing animal welfare concerns from paid or unpaid staff within the institution in a timely manner, and without retribution.

Chapter 9

(1.6.4) The institution should follow a formal written animal training program that facilitates husbandry, science, and veterinary procedures and enhances the overall health and well-being of the animals.

(1.6.1) The institution must follow a formal written enrichment program that promotes species-appropriate behavioral opportunities.

(1.6.3) Enrichment activities must be documented and evaluated, and program refinements should be made based on the results, if appropriate. Records must be kept current.

(1.6.2) The institution must have a specific paid staff member(s) or committee assigned for enrichment program oversight, implementation, assessment, and interdepartmental coordination of enrichment efforts.

Chapter 10

(1.5.4) If ambassador animals are used, a written policy on the use of live animals in programs must be on file and incorporate the elements contained in AZA's "Recommendations For Developing an Institutional Ambassador Animal Policy" (see policy in the current edition of the *Accreditation Standards and Related Policies* booklet). An education, conservation, and welfare message must be an integral component of all programs. Animals in education programs must be maintained and cared for by paid and/or unpaid trained staff, and housing conditions must meet standards required for the remainder of the animals in the institution. While outside their primary enclosure, although the conditions may be different, animal safety and welfare need to be assured at all times.

(1.5.3) If animal demonstrations are a part of the institution's programs, an educational/conservation message must be an integral component.

(1.5.12) Paid and/or unpaid staff assigned to handle animals during demonstrations or educational programs must be trained in accordance with the institution's written animal handling protocols. Such training must take place before handling may occur.

(1.5.13) When in operation, animal contact areas (petting zoos, touch tanks, etc.) must be supervised by trained, paid and/or unpaid staff.

Chapter 11

(5.3) The institution should maximize the generation and dissemination of scientific knowledge gained. This might be achieved by participating in AZA TAG/SSP sponsored studies when applicable, conducting and publishing original research projects, affiliating with local universities, and/or employing staff with scientific credentials.

(5.0) The institution must have a demonstrated commitment to scientific study that is in proportion to the size and scope of its facilities, staff (paid and unpaid), and animals.

(5.2) The institution must follow a formal written policy that includes a process for the evaluation and approval of scientific project proposals, and outlines the type of studies it conducts, methods, staff (paid and unpaid) involvement, evaluations, animals that may be involved, and guidelines for publication of findings.

(5.1) Scientific studies must be under the direction of a paid or unpaid staff member or committee qualified to make informed decisions.

Appendix B: Recordkeeping Guidelines for Group Accessions

Developed by the AZA Institutional Data Management Scientific Advisory Group
Published 23 May 2014
Edited to replace the document entitled "Updated Data Entry for Groups" published 16 December 2002

Animals can be accessioned into a collection as either individuals or as part of a group. The term "group" has many definitions when used in zoos and aquariums, and is usually defined by its application, such as a social group or animals grouped for husbandry purposes. To provide a consistent language that can be used throughout the Association of Zoos and Aquariums (AZA), the term "group accession", as defined by the AZA Institutional Data Management Scientific Advisory Group (IDMAG),

- contains multiple animals of the same species or subspecies, which
- cannot be differentiated from one another, either physically (there are no scars or color pattern differences), artificially (they are not tagged or transpondered), or spatially (they are not held in separate enclosures), and
- are cared for as a whole.

Thus, no individually accessioned animals are included in a group accession and no individually *identifiable* animals are included in a group accession. As soon as an animal becomes individually identifiable, it is recommended that it be split from the group record and accessioned as an individual. For example, large clutches of amphibian tadpoles should first be accessioned as a group; then as individuals become identifiable, they should be removed from the group record and accessioned as individuals. Otherwise, information about an individual animal that could otherwise be tracked through the animal's life will be lost in the group record. An exception to this occurs occasionally when a group member is removed and temporarily held separately for medical treatment, with the expectation that it will be returned to the group when treatment ends. In this case, the animal remains part of the group even though separated from it. As with individual records, group record accession numbers should not duplicate any other accession number, and once a group accession number has been assigned, it should not be changed.

Group accession provides less information on specific individuals than does individual accession. Group records make information less retrievable, and often need more clarifying comments than individual records. Whenever information applies to only part of the group, notes should be used to indicate which animal(s) the information applies to. It is of utmost importance that these notes be thorough and clear so future readers can easily understand them. Examples of information needing additional notations in group records include, but are not limited to, parentage when not every member of the group has the ˇthe group. Thus, though it is preferable to accession animals as individuals, a group accession can capture considerable information when individual accession is not appropriate.

Although colonies are often confused with groups, the term "colony" should be used to designate truly colonial organisms: those that must live and function as an intact unit, such as corals and eusocial insects. Individuals within a colony are components of a single entity rather than separate members of a group. Also, colony members generally cannot be counted and true census data is not possible, so for the purposes of inventory, a colony is a singular unit while a group is composed of a number of individuals. However, for accessioning purposes, colonies are treated in the same manner as are groups.

Examples of Appropriate Group Accessions

- A group of animals that are not individually identifiable and are the same species or subspecies.

  Your institution receives 50 Puerto Rican crested toad tadpoles to rear. Unless each tadpole is raised in a separate numbered tank, there is no way to tell one tadpole from another. All tadpoles housed together are accessioned as one group.
- Colonial species, such as coral or eusocial insects (e.g., some species of bees or ants).

  Your institution receives a piece of coral. Since the coral is in one piece, you accession it as a group of one. You make a note of the dimensions or mass of the piece to give an estimate of colony size, since it is not possible to count individual animals in the colony. In the inventory, the colony counts as one animal. When a section of the coral breaks off, you accession that new piece as a new colony.

- A self-sustaining, breeding group of small rodents or insects.

  Your institution has a large number of Cairo spiny mice. No daily count is made, though births and deaths increase and decrease the count. A census is taken periodically, and the new count is recorded by sex and life stage. Exact counts are made whenever possible – for example, when the group is moved to a new enclosure.
- Young born to several females of the same species or subspecies and raised together without means of identifying which offspring were born to which mother.

  A flock of 3.6 peafowl raise 25 chicks this year. Identity of the hens incubating each nest, hatch dates, and number of chicks hatched from each nest can be determined and recorded. However, unless the chicks are caught and banded at hatching, once the mothers and chicks join the main flock, it is no longer possible to tell which chicks belong to which females. All chicks in the flock have the same possible parents: all the peacocks and those peahens that incubated the nests. The chicks are accessioned as a group and are split out only when they are banded or tagged (and are thus individually identifiable).
- Historical records for a species or subspecies for which there is insufficient information to attribute events to specific individuals.

  Some of your historical records are found as simple lists of events. Though there are dates for all transactions, and maybe even specified vendors or recipients for those events, you cannot create individual records for any of these animals without additional information: there is nothing connecting any specific individual to both acquisition and disposition information. If additional information is uncovered that makes this connection, then that individual can be removed from the group accession and given an individual record.

Managing Group Records

Maintaining Group Records - As with individual records, group records should also be maintained and updated. Addition of animals through births or transactions such as loans, purchases, donations, or trades are entered as acquisitions. Subtraction of animals through deaths or transactions such as loans, sales, donations, or trades are entered as dispositions.

Weights and lengths can be entered into a group record even if that data cannot be attributed to a specific individual. This information is still useful in describing the overall condition of group members, although care should be given to describe the animal that the measurement came from. For example, is the animal a juvenile or a breeding adult? Is it healthy, or sickly? Alternatively, average and/or median measurements can be entered into the record to give an indication of what size a "normal" individual might be. In this case, notes should include the maximum and minimum measurements, and how many animals were measured to calculate the average or median.

Censuses - Groups should be censused at regular intervals - ideally, no longer than one inter-birth interval. Institutions should establish and follow a census schedule for each group. An inventory must be done at least once yearly (AZA Accreditation Standard 1.4.1) but the frequency at which a group is censused depends on species biology, husbandry protocols, and animal welfare. For species in which births/hatches and deaths tend to go undetected, or for species that have high fecundity and mortality (which makes counting every animal very difficult or impossible), census data should be obtained more frequently than for species with longer inter-birth intervals. These more frequent censuses should not be undertaken when intrusion on the group has a negative effect on the welfare of the group, e.g., disruption of maternal care.

Censuses should provide as much detail as possible by recording numbers in distinctive life stages (such as newborn, immature, adult) and/or sex ratio (such as male, female, unknown/undetermined). If the census count is estimated, the estimation method and (when possible) the accuracy of the estimate should be included. When updating the sex ratio, who sexed the animals and how they were sexed should also be recorded.

Splitting And Combining (Merging) Groups - Splitting animals from groups and combining groups together are realities of group management. Animals may be removed to create additional groups, or perhaps new animals are received from another institution. When new groups are created, new group records also need to be created. However, if the entire group moves to a new location (such as a different tank), it retains the same accession number, and notation of the change in location is made.

When a single group is split into two or more groups, one of the new groups keeps the original accession number and the others are assigned new accession numbers. This is also true if a portion of a group is sent to another institution: the subgroup making the transfer must have an accession number distinct from that of the main group. The accession number(s) for the new group(s) should follow institutional procedures for the assignment of new accession numbers. Note of the new group accession number(s) should appear in the originating group record, and the new group accession record(s) should contain the originating group number. The reason for the split should be entered into both the originating and new group records.

When two or more groups combine to form a larger group, all but one of the groups are deaccessioned and their counts brought to zero. Notes in all the group records should indicate why the groups were merged, as well as the accession numbers of all groups involved – both the closed (empty) groups and the remaining group.

In all cases of splits and merges, the date of creation of the new record should be the same as the date of removal from the previous group or individual. Detailed notes should explain the reasons for all splits and merges.

Merging Individuals in to Groups and Splitting Individuals from Groups - Good husbandry dictates the use of identification methods that allow animals to be tracked as individuals whenever possible (AZA Accreditation Standard 1.4.3). Thus, most institutions initially accession newly-acquired animals as individual animals with individual identifiers.

Despite the best intentions, individual identification sometimes becomes impossible. For example, birds in large aviaries lose their bands; small frogs in a large terrarium die and decompose without being noticed. When individual identification of several of the animals in the group is lost and can't be resolved in a reasonable amount of time, it is best to move all potentially unidentifiable animals to a group record, by either creating a new group or merging them into an existing group. As with splitting and merging groups, the group record should contain the identities of the originating individuals and the individual records should show the new group identity. If the animals in the group ever become individually identifiable again, they can be split back to individual records to better capture demographic information. If this occurs, new accession numbers are generally needed for the new individual records since it is rarely possible to know which old individual record would apply to the newly identifiable group member.

Conversely, if one or more group members become identifiable, for example, the previously unbanded young of the year are caught up and banded, they should be split from the group record and given individual accessions. The group record should include the individual numbers assigned, and the records of all individuals should show the number of the originating group. In the case of new individual records, information particular to the animal being given the individual record (if known) should be transferred to the individual record. This includes birth date, origin, parent identification, etc. As in the cases of splitting and merging groups, the date of creation of the new record is the same as the date of removal from the previous group or individual, and detailed notes should explain the reasons for all changes in accession type.

Transfers Between Institutions - When accessioning a number of animals that were received from another institution, the new animals should be accessioned using the same type of record that the sending institution used, regardless of how the animals will ultimately be managed. If a group is received but the members will be managed as individuals, they should be accessioned as a group first, then split out as individuals. Similarly, if a number of individuals are received but the plan is to manage them as a group, they should be accessioned as individuals, then merged into a group. Although this is an extra step in the accession process, it allows the records from both institutions to more seamlessly link.

Removing Individuals From Historical Group Records - The decision of whether to use individual or group accession for historical records should be made thoughtfully and carefully. As detailed above, group accession should be used if there is insufficient information to create an *accurate* individual record. The use of group accession is preferable to the inclusion of "best guess" information, i.e. fiction, to fill the information necessary to complete an individual record.

If additional information is later found that allows the creation of an individual record for one of the members of a historical group record, the procedure for removal from the group is different from that for current records. This situation is treated differently because the historical individual was not truly part of a group accession – the information necessary for a complete individual record was merely not known and the

group accession was used “temporarily” until the required information was found or learned. For this reason, the individual should NOT be split from the group, but all reference to the individual should instead be *deleted entirely* from the group, as if it were never part of the group. This will allow the individual record to begin with the initial acquisition (instead of the date of removal from a group) and will include the animal’s entire history in one record. It also prevents inflation of inventory numbers by eliminating the possible duplication of the same information in both the group and the individual records.

Appendix C: Guidelines for Creating and Sharing Animal and Collection Records

Developed by the AZA Institutional Data Management Scientific Advisory Group
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The goal of maintaining a centralized, compiled record for each animal cared for in a zoo or aquarium is ideal, however, oftentimes, information belonging in an animal record is spread across many departments and may originate with any member of the animal care staff. Therefore, it is important for zoos and aquariums to have a formal method for collecting or linking various pieces of information into the official records and that the roles and responsibilities for each named record type are clearly defined in written protocols for the reporting, recording, distribution, storage, and retrieval processes; there should also be a stated process of review for the accuracy and completeness of these records. For example, a recording/reporting protocol would state who reports births or deaths, to whom they are reported, in what manner and in what time frame they are reported, who officially records the information, and who reviews the resulting record for accuracy and completeness. Then, the maintenance and archiving protocol would state where the record is to be filed, who may have access, and how long the record is to be maintained before being archived or disposed of.

Information contained in animal records is essential not only to the immediate care of the individual animal but also as pooled data to manage larger concerns (e.g., providing norms for species-related veterinary and population management decisions, evidence of compliance with laws and regulations, showing trends in populations on every level from institutional to global, etc.). No matter what its use, it is critical for the information contained in an animal record to be factual, clear, complete, and documented. Because zoos and aquariums vary greatly in size and organizational structure, it is impossible to set defined procedures that would be applicable to all; therefore the following guidelines for creating and sharing animal records have been developed to assist with the establishment of written policies that best fit their own internal structure and protocols.

Animal and Collection Records – Definitions and Examples

The AZA Institutional Data Management Scientific Advisory Group (IDMAG) defines an animal record as: *"data, regardless of physical form or medium, providing information about individual animals, groups of animals, or samples or parts thereof".* An animal's record may include, but is not limited to, information about its provenance, history, daily care, activities, and condition; some may originate in non-animal care departments. Some examples of animal records are:

- transaction documents (including proof of legal ownership, purchase contracts, etc.)
- identification information
- reports of collection changes (including in-house moves)
- pedigrees/lineages
- veterinary information, including images, test results, etc.
- nutrition and body condition information
- information on sampling and parts/products distribution

In addition, the IDMAG defines collection records as: *"information, evidence, rationalizations about an animal collection as a whole that may supplement or explain information contained in an animal record"*. Collection records may include, but are not limited to, documentation of collection decisions and changes, evidence of structural change at the institution, evidence of building name changes, and documentation of institution level or unit level husbandry protocols and changes. Some examples of collection records are:

- collection plans
- permits
- annual inventories (which include reconciliation with the previous year)
- area journals/notebooks (including information to/from/between other animal care staff)
- keeper reports

- animal management protocols (e.g., species hand-rearing protocols, special care or treatments, etc.)
- enclosure maps/trees
- enclosure/exhibit information (monitoring, maintenance, modifications, etc.)
- research plans and published papers

Animal and Collection Records - Development

It is recommended that each zoo and aquarium develop written policies and procedures, applicable to all staff involved with animal care, that:

- define the types of records that are required.
  For example, daily keeper reports might be required from the keeper staff and weekly summaries of activities might be required from the animal curator and senior veterinarian.
- define the information that is to be included in each type of record.
  Following the example above, the institution would state the specific types of information to be recorded on the daily keeper report and the weekly summaries.
- define the primary location where each record can be found.
  For example, if a zoo does not employ a nutritionist, the policy or procedures might state that animal diet information will be found in keeper daily reports, curator-developed daily diets, and/or veterinarian-prescribed treatment diets.
- assign responsibility for the generation of each record type and set time limits for the their creation.
  For example, keepers might be held responsible for producing daily reports by the start of the next day and curators might be held responsible for producing weekly summaries by the Tuesday of the following week.
- define a process to review the accuracy of each record type and assign responsibility for that review process.
  For example, the identity of who will review each type of record, the date of reviews, and the review/correction processes might be included in the policy.
- define a process to identify official records and assign responsibility for the recording of, or linking of, information into these records.
  For example, the identity of who will be responsible for placing information into the official records and the processes of how to identify official records might be included in the policy.
- ensure entries in official records are never erased or deleted.
  For example, if an entry is determined to be erroneous, rather than deleting it, the entry should be amended and an audit trail should be created that identifies what data was changed, who made the change, the date it was changed, and the reason for the change.
- ensure records relating to specific animals in the collection, including the records of non--animal care departments, are permanently archived as part of the animal's record.
  For example, if your zoo or aquarium's records retention schedules differ from this recommendation every attempt should be made to exempt these records from schedules requiring their destruction.

Animal and Collection Records – Sharing of Information

Each zoo and aquarium should assess the ownership of their animal and collection records and determine the rights of employees and outside entities to the information contained in them. It is recommended that each zoo and aquarium develop written policies and procedures for the distribution and/or availability of the animal and collection records that:

- identify who has access to animal and collection records and under what conditions.
  For example, animal care staff whose duties require a direct need for information about specific animals or collection of animals should be identified as individuals who are allowed access to any or specified records, regardless of who created them or when they were created.
- assign responsibility for the distribution, archiving and retrieval of each record type.
  For example, the recordkeeper or registrar might be held responsible for maintaining all past and current transaction documents and the curator might be held responsible for maintaining the daily keeper reports from his/her section.

- define a notification system that specifies what information will be provided in the notification, who will be notified, the date they will be notified by, and the mechanism that will be used to ensure the notification is communicated appropriately.
    For example, the shipment of an animal might require that written notice be made to the senior keeper in the animal's area, the curator, and the veterinarian at least 30 days prior to the move, and identifies the animal by group or individual identification/accession number, sex, and tag/transponder number, etc.
- define where each record type (stored or archived) is available and what format (paper or digital) it is in.
    For example, all original animal transaction documents might be kept in the registrar's office in fire-proof file cabinets but copies of the Animal Data Transfer Forms are kept in the appropriate keeper area.
- define a system for obtaining necessary information such that the information is available regardless of department and regardless of staffing issues
    For example, keeper daily reports might be maintained in an electronic database run on the institution's network, to which all animal care staff members have at least read-only access.

Implementation of these Recommendations

Well-written, consistent data-recording protocols and clear lines of communication will increase the quality of animal records and should be implemented by all institutions, regardless of technical resources. While the best option for availability of information is an electronic database system run on a computer network (intranet) to which all animal care staff members have unrestricted access, the above recommendations may also be adopted by zoos and aquariums without full electronic connections.

Appendix D: AZA Policy on Responsible Population Management

PREAMBLE

The stringent requirements for AZA accreditation, and high ethical standards of professional conduct, are unmatched by similar organizations and far surpass the United States Department of Agriculture's Animal and Plant Health Inspection Service's requirements for licensed animal exhibitors. Every AZA member must abide by a Code of Professional Ethics (https://www.aza.org/code-of-ethics). In order to continue these high standards, AZA-accredited institutions and certified related facilities should make it a priority, when possible, to acquire animals from and transfer them to other AZA member institutions, or members of other regional zoo associations that have professionally recognized accreditation programs.

AZA-accredited institutions and certified related facilities cannot fulfill their important missions of conservation, education, and science without live animals. Responsible management and the long-term sustainability of living animal populations necessitates that some individuals be acquired and transferred, reintroduced or even humanely euthanized at certain times. The acquisition and transfer of animals should be prioritized by the long-term sustainability needs of the species and AZA-managed populations among AZA-accredited and certified related facilities, and between AZA member institutions and non-AZA entities with animal care and welfare standards aligned with AZA. AZA member institutions that acquire animals from the wild, directly or through commercial vendors, should perform due diligence to ensure that such activities do not have a negative impact on species in the wild. Animals should only be acquired from non-AZA entities that are known to operate legally and conduct their business in a manner that reflects and/or supports the spirit and intent of the AZA Code of Professional Ethics as well as this Policy.

I. INTRODUCTION

This AZA Policy on Responsible Population Management provides guidance to AZA members to:

1. Assure that animals from AZA member institutions and certified related facilities are not transferred to individuals or organizations that lack the appropriate expertise or facilities to care for them [*see taxa specific appendices (in development)*],

2. Assure that the health and conservation of wild populations and ecosystems are carefully considered as appropriate,

3. Maintain a proper standard of conduct for AZA members during acquisition and transfer/reintroduction activities, including adherence to all applicable laws and regulations,

4. Assure that the health and welfare of individual animals is a priority during acquisition and transfer/reintroduction activities, and

5. Support the goals of AZA's cooperatively managed populations and associated Animal Programs [Species Survival Plans® (SSPs), Studbooks, and Taxon Advisory Groups (TAGs)].

This AZA Policy on Responsible Population Management will serve as the default policy for AZA member institutions. Institutions should develop their own Policy on Responsible Population Management in order to address specific local concerns. Any institutional policy must incorporate and not conflict with the AZA acquisition and transfer/transition standards.

II. LAWS, AUTHORITY, RECORD-KEEPING, IDENTIFICATION AND DOCUMENTATION

The following must be considered with regard to the acquisition or transfer/management of all living animals and specimens (their living and non-living parts, materials, and/or products):

1. Any acquisitions, transfers, euthanasia and reintroductions must meet the requirements of all applicable local, state, federal, national, and international laws and regulations. Humane euthanasia must be performed in accordance with the established euthanasia policy of the institution and follow the recommendations of current AVMA Guidelines for the Euthanasia of Animals (2013 Edition https://www.avma.org/KB/Policies/Documents/euthanasia.pdf) or the AAZV's Guidelines on the Euthanasia of Non-Domestic Animals. Ownership and any applicable chain-of-custody must be documented. If such information does not exist, an explanation must be provided regarding such animals and specimens. Any acquisition of free-ranging animals must be done in accordance with all local, state, federal, national, and international laws and regulations and must not be detrimental to the long-term viability of the species in the wild.

2. The Director/Chief Executive Officer of the institution must have final authority for all acquisitions, transfers, and euthanasia.

3. Acquisitions or transfers/euthanasia/reintroductions must be documented through institutional record keeping systems. The ability to identify which animal is being transferred is very important and the method of identifying each individual animal should be documented. Any existing documentation must accompany all transfers. Institutional animal records data, records guidelines have been developed for certain species to standardize the process (https://www.aza.org/idmag-documents-and-guidelines).

4. For some colonial, group-living, or prolific species, it may be impossible or highly impractical to identify individual animals when these individuals are maintained in a group. These species can be maintained, acquisitioned, transferred, and managed as a group or colony, or as part of a group or colony.

5. If the intended use of specimens from animals either living or non-living is to create live animal(s), their acquisition and transfer should follow the same guidelines. If germplasm is acquired or transferred with the intention of creating live animal(s), ownership of the offspring must be clearly defined in transaction documents (e.g., breeding loan agreements).

   Institutions acquiring, transferring or otherwise managing specimens should consider current and possible future uses as new technologies become available. All specimens from which nuclear DNA could be recovered should be carefully considered for preservation as these basic DNA extraction technologies already exist.

6. AZA member institutions must maintain transaction documents (e.g., confirmation forms, breeding agreements) which provide the terms and conditions of animal acquisitions, transfers and loans, including documentation for animal parts, products and materials. These documents should require the potential recipient or provider to adhere to the AZA Policy on Responsible Population Management, and the AZA Code of Professional Ethics, and must require compliance with the applicable laws and regulations of local, state, federal, national, and international authorities.

7. In the case of animals (living or non-living) and their parts, materials, or products (living or non-living) held on loan, the owner's written permission should be obtained prior to any transfer and documented in the institutional records.

8. AZA SSP and TAG necropsy and sampling protocols should be accommodated.

9. Some governments maintain ownership of the species naturally found within their borders. It is therefore incumbent on institutions to determine whether animals they are acquiring or transferring are owned by a government entity, foreign or domestic, and act accordingly by reviewing the government ownership policies available on the AZA website. In the case of government owned animals, proposals for and/or notifications of transfers must be sent to the species manager for the government owned species.

III. ACQUISITION REQUIREMENTS

A. General Acquisitions

1. Acquisitions must be consistent with the mission of the institution, as reflected in its Institutional Collection Plan, by addressing its exhibition/education, conservation, and/or scientific goals regarding the individual or species.

2. Animals (wild, feral, and domestic) may be held temporarily for reasons such as assisting governmental agencies or other institutions, rescue and/or rehabilitation, research, propagation or headstarting for reintroduction, or special exhibits.

3. Any receiving institution must have the necessary expertise and resources to support and provide for the professional care and management of the species, so that the physical, psychological, and social needs of individual animals and species are met.

4. If the acquisition involves a species managed by an AZA Animal Program, the institution should communicate with the Animal Program Leader and, in the case of Green SSP Programs, must adhere to the AZA Full Participation Policy (https://www.aza.org/board-approved-policies-and-position-statements).

5. AZA member institutions should consult AZA Wildlife Conservation and Management Committee (WCMC)-approved TAG Regional Collection Plans (RCPs), Animal Program Leaders, and AZA Animal Care Manuals (ACMs) when making acquisition decisions.

6. AZA member institutions that work with commercial vendors that acquire animals from the wild, must perform due diligence to assure the vendors' collection of animals is legal and using ethical practices. Commercial vendors should have conservation and animal welfare goals similar to those of AZA institutions.

7. AZA member institutions may acquire animals through public donations and other non-AZA entities when it is in the best interest of the animal and/or species.

B. Acquisitions from the Wild

Maintaining wild animal populations for exhibition, education and wildlife conservation purposes is a core function of AZA-member institutions. AZA zoos and aquariums have saving species and conservation of wildlife and wildlands as a basic part of their public mission. As such, the AZA recognizes that there are circumstances where acquisitions from the wild are needed in order to maintain healthy, diverse animal populations. Healthy, sustainable populations support the objectives of managed species programs and the core mission of AZA members. In some cases, acquiring individuals from the wild may be a viable option in addition to, or instead of, relying on breeding programs with animals already in human care.

Acquiring animals from the wild can result in socioeconomic benefit and environmental protection and therefore the AZA supports environmentally sustainable/beneficial acquisition from the wild when conservation is a positive outcome.

1. Before acquiring animals from the wild, institutions are encouraged to examine alternative sources including other AZA institutions and other regional zoological associations or other non-AZA entities.

2. When acquiring animals from the wild, both the long-term health and welfare impacts on the wild population as well as on individual animals must be considered. In crisis situations, when the survival of a population is at risk, rescue decisions will be made on a case-by-case basis by the appropriate agency and institution.

3. AZA zoos and aquariums may assist wildlife agencies by providing homes for animals born in nature if they are incapable of surviving on their own (e.g., in case of orphaned or injured animals) or by euthanizing the animals because they pose a risk to humans or for humane reasons.
4. Institutions should only accept animals from the wild after a risk assessment determines the zoo/aquarium can mitigate any potential adverse impacts on the health, care and maintenance of the existing animals already being housed at the zoo or aquarium, and the new animals being acquired.

IV. TRANSFER, EUTHANASIA AND REINTRODUCTION REQUIREMENTS

A. Living Animals

Successful conservation and animal management relies on the cooperation of many entities, both AZA and non-AZA. While preference is given to placing animals with AZA-accredited institutions or certified related facilities, it is important to foster a cooperative culture among those who share AZA's mission of saving species and excellence in animal care.

1. AZA members should assure that all animals in their care are transferred, humanely euthanized and/or reintroduced in a manner that meets the standards of AZA, and that animals are not transferred to those not qualified to care for them properly. Refer to IV.12, below, for further requirements regarding euthanasia.

2. If the transfer of animals or their specimens (parts, materials, and products) involves a species managed by an AZA Animal Program, the institution should communicate with that Animal Program Leader and, in the case of Green SSP Programs must adhere to the AZA Full Participation Policy (https://www.aza.org/board-approved-policies-and-position-statements).

3. AZA member institutions should consult WCMC-approved TAG Regional Collection Plans, Animal Program Leaders, and Animal Care Manuals when making transfer decisions.

4. Animals acquired solely as a food source for animals in the institution's care are not typically accessioned. There may be occasions, however, when it is appropriate to use accessioned animals that exceed population carrying capacity as feeder animals to support other animals. In some cases, accessioned animals may have their status changed to "feeder animal" status by the institution as part of their program for long-term sustained population management of the species.

5. In transfers to non-AZA entities, AZA members must perform due diligence and should have documented validation, including one or more letters of reference, for example from an appropriate AZA Professional Fellow or other trusted source with expertise in animal care and welfare, who is familiar with the proposed recipient and their current practices, and that the recipient has the expertise and resources required to properly care for and maintain the animals. Any recipient must have the necessary expertise and resources to support and provide for the professional care and management of the species, so that the physical, psychological, and social needs of individual animals and species are met within the parameters of modern zoological philosophy and practice. Supporting documentation must be kept at the AZA member institution (see #IV.9 below).

6. Domestic animals should be transferred in accordance with locally acceptable humane farming practices, including auctions, and must be subject to all relevant laws and regulations.

7. AZA members must not send any non-domestic animal to auction or to any organization or individual that may display or sell the animal at an animal auction. *See certain taxa-specific appendices to this Policy (in development) for information regarding exceptions*.

8. Animals must not be sent to organizations or individuals that allow the hunting of these individual animals; that is, no individual animal transferred from an AZA institution may be hunted. For purposes of maintaining genetically healthy, sustainable zoo and aquarium populations, AZA-accredited

institutions and certified related facilities may send animals to non-AZA organizations or individuals (refer to #IV.5 above). These non-AZA entities (for instance, ranching operations) should follow appropriate ranch management practices and other conservation minded practices to support population sustainability.

9. Every loaning institution must annually monitor and document the conditions of any loaned specimen(s) and the ability of the recipient(s) to provide proper care (refer to #IV.5 above). If the conditions and care of animals are in violation of the loan agreement, the loaning institution must recall the animal or assure prompt correction of the situation. Furthermore, an institution's loaning policy must not be in conflict with this AZA Policy on Responsible Population Management.

10. If living animals are sent to a non-AZA entity located in the U.S. for research purposes, it must be a registered research facility by the U.S. Department of Agriculture and accredited by the Association for the Assessment & Accreditation of Laboratory Animal Care, International (AAALAC), if eligible. For international transactions, the receiving facility must be registered by that country's equivalent body having enforcement over animal welfare. In cases where research is conducted, but governmental oversight is not required, institutions should do due diligence to assure the welfare of the animals during the research.

11. Reintroductions and release of animals into the wild must meet all applicable local, state, and international laws and regulations. Any reintroduction requires adherence to best health and veterinary practices to ensure that non-native pathogens are not released into the environment exposing naive wild animals to danger. Reintroductions may be a part of a recovery program and must be compatible with the IUCN Reintroduction Specialist Group's Reintroduction Guidelines (http://www.iucnsscrsg.org/index.php).

12. Humane euthanasia may be employed for medical reasons to address quality of life issues for animals or to prevent the transmission of disease. AZA also recognizes that humane euthanasia may be employed for managing the demographics, genetics, and diversity of animal populations. Humane euthanasia must be performed in accordance with the established euthanasia policy of the institution and follow the recommendations of current AVMA Guidelines for the Euthanasia of Animals (2013 Edition https://www.avma.org/KB/Policies/Documents/euthanasia.pdf) or the AAZV's Guidelines on the Euthanasia of Non-Domestic Animals.

B. Non-Living Animals and Specimens

AZA members should optimize the use and recovery of animal remains. All transfers must meet the requirements of all applicable laws and regulations.

1. Optimal recovery of animal remains may include performing a complete necropsy including, if possible, histologic evaluation of tissues which should take priority over specimens' use in education/exhibits. AZA SSP and TAG necropsy and sampling protocols should be accommodated. This information should be available to SSP Programs for population management.

2. The educational use of non-living animals, parts, materials, and products should be maximized, and their use in Animal Program sponsored projects and other scientific projects that provide data for species management and/or conservation must be considered.

3. Non-living animals, if handled properly to protect the health of the recipient animals, may be utilized as feeder animals to support other animals as deemed appropriate by the institution.

4. AZA members should consult with AZA Animal Program Leaders prior to transferring or disposing of remains/samples to determine if existing projects or protocols are in place to optimize use.

5. AZA member institutions should develop agreements for the transfer or donation of non-living animals, parts, materials, products, and specimens and associated documentation, to non-AZA

entities such as universities and museums. These agreements should be made with entities that have appropriate long term curation/collections capacity and research protocols, or needs for educational programs and/or exhibits.

DEFINITIONS

Acquisition: Acquisition of animals can occur through breeding (births, hatchings, cloning, and division of marine invertebrates = "fragging"), trade, donation, lease, loan, transfer (inter- and intra-institution), purchase, collection, confiscation, appearing on zoo property, or rescue and/or rehabilitation for release.

Annual monitoring and Due diligence: Due diligence for the health of animals on loan is important. Examples of annual monitoring and documentation include and are not limited to inventory records, health records, photos of the recipient's facilities, and direct inspections by AZA professionals with knowledge of animal care. The level of due diligence will depend on professional relationships.

AZA member institution: In this Policy "AZA member institutions" refers to AZA-accredited institutions and certified related facilities (zoological parks and aquariums). "AZA members" may refer to either institutions or individuals.

Data sharing: When specimens are transferred, the transferring and receiving institutions should agree on data that must be transferred with the specimen(s). Examples of associated documentation include provenance of the animal, original permits, tags and other metadata, life history data for the animal, how and when specimens were collected and conserved, etc.

Dispose: "Dispose/Disposing of" in this document is limited to complete and permanent removal of an individual via incineration, burying or other means of permanent destruction

Documentation: Examples of documentation include ZIMS records, "Breeding Loan" agreements, chain-of-custody logs, letters of reference, transfer agreements, and transaction documents. This is documentation that maximizes data sharing.

Domestic animal: Examples of domestic animals may include certain camelids, cattle, cats, dogs, ferrets, goats, pigs, reindeer, rodents, sheep, budgerigars, chickens, doves, ducks, geese, pheasants, turkeys, and goldfish or koi.

Ethics of Acquisition/Transfer/Euthanasia: Attempts by members to circumvent AZA Animal Programs in the acquisition of animals can be detrimental to the Association and its Animal Programs. Such action may also be detrimental to the species involved and may be a violation of the Association's Code of Professional Ethics. Attempts by members to circumvent AZA Animal Programs in the transfer, euthanasia or reintroduction of animals may be detrimental to the Association and its Animal Programs (unless the animal or animals are deemed extra in the Animal Program population by the Animal Program Coordinator). Such action may be detrimental to the species involved and may be a violation of the Association's Code of Professional Ethics.

"Extra" or Surplus: AZA's scientifically-managed Animal Programs, including SSPs, have successfully bred and reintroduced critically endangered species for the benefit of humankind. To accomplish these critical conservation goals, populations must be managed within "carrying capacity" limits. At times, the number of individual animals in a population exceeds carrying capacity, and while meaning no disrespect for these individual animals, we refer to these individual animals as "extra" within the managed population.

Euthanasia: Humane death. This act removes an animal from the managed population. Specimens can be maintained in museums or cryopreserved collections. Humane euthanasia must be performed in accordance with the established euthanasia policy of the institution and follow the recommendations of current AVMA Guidelines for the Euthanasia of Animals (2013 Edition https://www.avma.org/KB/Policies/Documents/euthanasia.pdf) or the AAZV's Guidelines on the Euthanasia of Non-Domestic Animals.

Feral: Feral animals are animals that have escaped from domestication or have been abandoned to the wild and have become wild, and the offspring of such animals. Feral animals may be acquired for temporary or permanent reasons.

Group: Examples of colonial, group-living, or prolific species include and are not limited to certain terrestrial and aquatic invertebrates, fish, sharks/rays, amphibians, reptiles, birds, rodents, bats, big herds, and other mammals,

Lacey act: The Lacey Act prohibits the importation, exportation, transportation, sale, receipt, acquisition or purchase of wildlife taken or possessed in violation of any law, treaty or regulation of the United States or any Indian tribal law of wildlife law. In cases when there is no documentation accompanying an acquisition, the animal(s) may not be transferred across state lines. If the animal was illegally acquired at any time then any movement across state or international borders would be a violation of the Lacey Act.

Museum: It is best practice for modern zoos and aquariums to establish relationships with nearby museums or other biorepositories, so that they can maximize the value of animals when they die (e.g., knowing who to call when they have an animal in necropsy, or specimens for cryopreservation). Natural history museums that are members of the Natural Science Collections Alliance (NSCA) and frozen biorepositories that are members of the International Society of Biological and Environmental Repositories (ISBER) are potential collaborators that could help zoos find appropriate repositories for biological specimens.

Non-AZA entity: Non – AZA entities includes facilities not accredited or certified by the AZA, facilities in other zoological regions, academic institutions, museums, research facilities, private individuals, etc.

Reintroduction: Examples of transfers outside of a living zoological population include movements of animals from zoo/aquarium populations to the wild through reintroductions or other legal means.

Specimen: Examples of specimens include animal parts, materials and products including bodily fluids, cell lines, clones, digestive content, DNA, feces, marine invertebrate (coral) fragments ("frags"), germplasm, and tissues.

Transaction documents: Transaction documents must be signed by the authorized representatives of both parties, and copies must be retained by both parties*. In the case of loans, the owner's permission for appropriate activities should be documented in the institutional records. This document(s) should be completed prior to any transfer. In the case of rescue, confiscation, and evacuation due to natural disasters, it is understood that documents may not be available until after acceptance or shipping. In this case documentation (e.g., a log) must be kept to reconcile the inventory and chain of custody after the event occurs. (*In the case of government owned animals, notification of transfers must be sent to species manager for the government owned species).

Transfer: Transfer occurs when an animal leaves the institution for any reason. Reasons for transfer or euthanasia may include cooperative population management (genetic, demographic or behavioral management), animal welfare or behavior management reasons (including sexual maturation and individual management needs). Types of transfer include withdrawal through donation, trade, lease, loan, inter- and intra-institution transfers, sale, escape, theft. Reintroduction to the wild, humane euthanasia or natural death are other possible individual animal changes in a population.

RECIPIENT PROFILE EXAMPLE

Example questions for transfers to non-AZA entities (from AZA-member Recipient Profile documents):

Has your organization, or any of its officers, been indicted, convicted, or fined by a State or Federal agency or any national agency for any statute or regulation involving the care or welfare of animals housed at your facility? (If yes, please explain on a separate sheet).

Recipients agree that the specimen(s) or their offspring will not be utilized, sold or traded for any purpose contrary to the Association of Zoos and Aquariums (AZA) Code of Ethics (enclosed)

References, other than (LOCAL ZOO/AQUARIUM) employees, 2 minimum (please provide additional references on separate sheet):

Reference Name		Phone	
Facility		Fax	
Address		E-mail	
City	State		Zip
Country		AZA Member?	
Reference Name		Phone	
Facility		Fax	
Address		E-mail	
City	State		Zip
Country		AZA Member?	

Veterinary Information:

Veterinarian		Phone	
Clinic/Practice		Fax	
Address		E-mail	
City	State		Zip
Country			

How are animals identified at your facility? If animals are not identified at your facility, please provide an explanation about why they are not here:

Where do you acquire and send animals? (Select all that apply)

AZA Institutions	Non-AZA Institutions	Exotic Animal Auctions	Pet Stores
Hunting Ranches	Dealers	Private Breeders	Non-hunting Game Ranches
Entertainment Industry	Hobbyists	Research Labs	Wild
Other			

What specific criteria are used to evaluate if a facility is appropriate to receive animals from you?

Please provide all of the documents listed below:
Required:
1. Please provide a brief statement of intent for the specimens requested.
2. Resumes of primary caretakers and those who will be responsible for the husbandry and management of animals.
3. Description (including photographs) of facilities and exhibits where animals will be housed.
4. Copy of your current animal inventory.

Only if Applicable:
5. Copies of your last two USDA inspection reports (if applicable).
6. Copies of current federal and state permits.
7. Copy of your institutional acquisition/disposition policy.

(in-house use only) In-Person Inspection of this facility (Staff member/Date, attach notes):

(Local institution: provide Legal language certifying that the information contained herein is true and correct)

(Validity of this: This document and all materials associated will be valid for a period of 2 years from date of signature.)

Example agreement for receiving institution (agrees to following condition upon signing):
RECIPIENT AGREES THAT THE ANIMAL(S) AND ITS (THEIR) OFFSPRING WILL NOT BE UTILIZED, SOLD OR TRADED FOR THE PURPOSE OF COMMERCE OR SPORT HUNTING, OR FOR USE IN ANY STRESSFUL OR TERMINAL RESEARCH OR SENT TO ANY ANIMAL AUCTION. RECIPIENT FURTHER AGREES THAT IN THE EVENT THE RECIPIENT INTENDS TO DISPOSE OF AN ANIMAL DONATED BY (INSTITUTION), RECIPIENT WILL FIRST NOTIFY (INSTITUTION) OF THE IDENTITY OF THE PROPOSED TRANSFEREE AND THE TERMS AND CONDITIONS OF SUCH DISPOSITION AND WILL PROVIDE (INSTITUTION) THE OPPORTUNITY TO ACQUIRE THE ANIMAL(S) WITHOUT CHARGE. IF (INSTITUTION) ELECTS NOT TO RECLAIM THE ANIMAL WITHIN TEN (10) BUSINESS DAYS FOLLOWING SUCH NOTIFICATION, THEN, IN SUCH EVENT, (INSTITUTION) WAIVES ANY RIGHT IT MAY HAVE TO THE ANIMAL AND RECIPIENT MAY DISPOSE OF THE ANIMAL AS PROPOSED.

Institutional note: The text above is similar to the language most dog breeders use in their contracts when they sell a puppy. If people can provide that protection to the puppies they place, zoos/aquariums can provide it for animals that we place too! Some entities have been reluctant to sign it, and in that case we revert to a loan and our institution retains ownership of the animal. Either way, we are advised of the animal's eventual placement and location.

Appendix E: Recommended Quarantine Procedures

Quarantine facility: A separate quarantine facility, with the ability to accommodate mammals, birds, reptiles, amphibians, and fish should exist. If a specific quarantine facility is not present, then newly acquired animals should be isolated from the established collection in such a manner as to prohibit physical contact, to prevent disease transmission, and to avoid aerosol and drainage contamination.

Such separation should be obligatory for primates, small mammals, birds, and reptiles, and attempted wherever possible with larger mammals such as large ungulates and carnivores, marine mammals, and cetaceans. If the receiving institution lacks appropriate facilities for isolation of large primates, pre-shipment quarantine at an AZA or American Association for Laboratory Animal Science (AALAS) accredited institution may be applied to the receiving institutions protocol. In such a case, shipment must take place in isolation from other primates. More stringent local, state, or federal regulations take precedence over these recommendations.

Quarantine length: Quarantine for all species should be under the supervision of a veterinarian and consist of a minimum of 30 days (unless otherwise directed by the staff veterinarian). Mammals: If during the 30-day quarantine period, additional mammals of the same order are introduced into a designated quarantine area, the 30-day period must begin over again. However, the addition of mammals of a different order to those already in quarantine will not have an adverse impact on the originally quarantined mammals. Birds, Reptiles, Amphibians, or Fish: The 30-day quarantine period must be closed for each of the above Classes. Therefore, the addition of any new birds into a bird quarantine area requires that the 30-day quarantine period begin again on the date of the addition of the new birds. The same applies for reptiles, amphibians, or fish.

Quarantine personnel: A keeper should be designated to care only for quarantined animals or a keeper should attend quarantined animals only after fulfilling responsibilities for resident species. Equipment used to feed and clean animals in quarantine should be used only with these animals. If this is not possible, then equipment must be cleaned with an appropriate disinfectant (as designated by the veterinarian supervising quarantine) before use with post-quarantine animals.

Institutions must take precautions to minimize the risk of exposure of animal care personnel to zoonotic diseases that may be present in newly acquired animals. These precautions should include the use of disinfectant foot baths, wearing of appropriate protective clothing and masks in some cases, and minimizing physical exposure in some species; e.g., primates, by the use of chemical rather than physical restraint. A tuberculin testing/surveillance program must be established for zoo/aquarium employees in order to ensure the health of both the employees and the animal collection.

Quarantine protocol: During this period, certain prophylactic measures should be instituted. Individual fecal samples or representative samples from large numbers of individuals housed in a limited area (e.g., birds of the same species in an aviary or frogs in a terrarium) should be collected at least twice and examined for gastrointestinal parasites. Treatment should be prescribed by the attending veterinarian. Ideally, release from quarantine should be dependent on obtaining two negative fecal results spaced a minimum of two weeks apart either initially or after parasiticide treatment. In addition, all animals should be evaluated for ectoparasites and treated accordingly.

Vaccinations should be updated as appropriate for each species. If the animal arrives without a vaccination history, it should be treated as an immunologically naive animal and given an appropriate series of vaccinations. Whenever possible, blood should be collected and sera banked. Either a 70 °C (-94 °F) frost-free freezer or a 20 °C (-4 °F) freezer that is not frost-free should be available to save sera. Such sera could provide an important resource for retrospective disease evaluation.

The quarantine period also represents an opportunity to, where possible, permanently identify all unmarked animals when anesthetized or restrained (e.g., tattoo, ear notch, ear tag, etc.). Also, whenever animals are restrained or immobilized, a complete physical, including a dental examination, should be performed. Complete medical records should be maintained and available for all animals during the quarantine period. Animals that die during quarantine should have a necropsy performed under the supervision of a veterinarian and representative tissues submitted for histopathologic examination.

Quarantine procedures: The following are recommendations and suggestions for appropriate quarantine procedures for [species/group]:

Species/Group:

Required:

1. Direct and floatation fecals
2. Vaccinate as appropriate

Strongly recommended:

1. CBC/sera profile
2. Urinalysis
3. Appropriate serology (FIP, FeLV, FIV)
4. Heartworm testing in appropriate species

Appendix F: Ambassador Animal Policy and Position Statement

Ambassador (Program) Animal Policy

Originally approved by the AZA Board of Directors—2003
Updated and approved by the Board—July 2008 & June 2011
Modified from "Program Animal" to "Ambassador Animal" to avoid confusion with "Animal Programs," approved by the CEC; no change to meaning of these terms - January 2015

The Association of Zoos & Aquariums (AZA) recognizes many benefits for public education and, ultimately, for conservation in ambassador animal presentations. AZA's Conservation Education Committee's *Ambassador Animal Position Statement* summarizes the value of ambassador animal presentations (see pages 42–44).

For the purpose of this policy, an Ambassador animal is defined as "an animal whose role includes handling and/or training by staff or volunteers for interaction with the public and in support of institutional education and conservation goals." Some animals are designated as Ambassador Animals on a full-time basis, while others are designated as such only occasionally. Ambassador Animal-related Accreditation Standards are applicable to all animals during the times that they are designated as Ambassador Animals.

There are three main categories of Ambassador Animal interactions:

1. On Grounds with the Ambassador Animal Inside the Exhibit/Enclosure:
    a. Public access outside the exhibit/enclosure. Public may interact with animals from outside the exhibit/enclosure (e.g., giraffe feeding, touch tanks).
    b. Public access inside the exhibit/enclosure. Public may interact with animals from inside the exhibit/enclosure (e.g., lorikeet feedings, 'swim with' programs, camel/pony rides).
2. On Grounds with the Ambassador Animal Outside the Exhibit/Enclosure:
    a. Minimal handling and training techniques are used to present Ambassador Animals to the public. Public has minimal or no opportunity to directly interact with Ambassador Animals when they are outside the exhibit/enclosure (e.g., raptors on the glove, reptiles held "presentation style").
    b. Moderate handling and training techniques are used to present Ambassador Animals to the public. Public may be in close proximity to, or have direct contact with, Ambassador Animals when they're outside the exhibit/enclosure (e.g., media, fund raising, photo, and/or touch opportunities).
    c. Significant handling and training techniques are used to present Ambassador Animals to the public. Public may have direct contact with Ambassador Animals or simply observe the in-depth presentations when they're outside the exhibit/enclosure (e.g., wildlife education shows).
3. Off Grounds:
    a. Handling and training techniques are used to present Ambassador Animals to the public outside of the zoo/aquarium grounds. Public may have minimal contact or be in close proximity to and have direct contact with Ambassador Animals (e.g., animals transported to schools, media, fundraising events).

These categories assist staff and accreditation inspectors in determining when animals are designated as Ambassador Animals and the periods during which the Ambassador Animal-related Accreditation Standards are applicable. In addition, these Ambassador Animal categories establish a framework for understanding increasing degrees of an animal's involvement in Ambassador Animal activities.

Ambassador Animal presentations bring a host of responsibilities, including the safety and welfare of the animals involved, the safety of the animal handler and public, and accountability for the take-home, educational messages received by the audience. Therefore, AZA requires all accredited institutions that make Ambassador Animal presentations to develop an institutional Ambassador Animal policy that clearly identifies and justifies those species and individuals approved as Ambassador Animals and details their long-term management plan and educational program objectives.

AZA's accreditation standards require that education and conservation messages must be an integral component of all Ambassador Animal presentations. In addition, the accreditation standards require that the conditions and treatment of animals in education programs must meet standards set for the remainder of the animal collection, including species-appropriate shelter, exercise, appropriate environmental enrichment, access to veterinary care, nutrition, and other related standards. In addition, providing Ambassador Animals with options to choose among a variety of conditions within their environment is essential to ensuring effective care, welfare, and management. Some of these requirements can be met outside of the primary exhibit enclosure while the animal is involved in a program or is being transported. For example, free-flight birds may receive appropriate exercise during regular programs, reducing the need for additional exercise. However, the institution must ensure that in such cases, the animals participate in programs on a basis sufficient to meet these needs or provide for their needs in their home enclosures; upon return to the facility the animal should be returned to its species-appropriate housing as described above.

Ambassador Animal Position Statement

Last revision 1/28/03
Re-authorized by the Board June 2011

The Conservation Education Committee (CEC) of the Association of Zoos and Aquariums supports the appropriate use of Ambassador Animals as an important and powerful educational tool that provides a variety of benefits to zoo and aquarium educators seeking to convey cognitive and affective (emotional) messages about conservation, wildlife and animal welfare.
Utilizing these animals allows educators to strongly engage audiences. As discussed below, the use of Ambassador Animals has been demonstrated to result in lengthened learning periods, increased knowledge acquisition and retention, enhanced environmental attitudes, and the creation of positive perceptions concerning zoo and aquarium animals.

Audience Engagement

Zoos and aquariums are ideal venues for developing emotional ties to wildlife and fostering an appreciation for the natural world. However, developing and delivering effective educational messages in the free-choice learning environments of zoos and aquariums is a difficult task.
Zoo and aquarium educators are constantly challenged to develop methods for engaging and teaching visitors who often view a trip to the zoo as a social or recreational experience (Morgan & Hodgkinson, 1999). The use of Ambassador Animals can provide the compelling experience necessary to attract and maintain personal connections with visitors of all motivations, thus preparing them for learning and reflection on their own relationships with nature.

Ambassador Animals are powerful catalysts for learning for a variety of reasons. They are generally active, easily viewed, and usually presented in close proximity to the public. These factors have proven to contribute to increasing the length of time that people spend watching animals in zoo exhibits (Bitgood, Patterson & Benefield, 1986, 1988; Wolf & Tymitz, 1981).

In addition, the provocative nature of a handled animal likely plays an important role in captivating a visitor. In two studies (Povey, 2002; Povey & Rios, 2001), visitors viewed animals three and four times longer while they were being presented in demonstrations outside of their enclosure with an educator than while they were on exhibit. Clearly, the use of Ambassador Animals in shows or informal presentations can be effective in lengthening the potential time period for learning and overall impact.

Ambassador Animals also provide the opportunity to personalize the learning experience, tailoring the teaching session to what interests the visitors. Traditional graphics offer little opportunity for this level of personalization of information delivery and are frequently not read by visitors (Churchman, 1985; Johnston, 1998). For example, Povey (2001) found that only 25% of visitors to an animal exhibit read the accompanying graphic; whereas, 45% of visitors watching the same animal handled in an educational presentation asked at least one question and some asked as many as seven questions. Having an animal accompany the educator allowed the visitors to make specific inquiries about topics in which they were interested.

Knowledge Acquisition

Improving our visitors' knowledge and understanding regarding wildlife and wildlife conservation is a fundamental goal for many zoo educators using Ambassador Animals. A growing body of evidence supports the validity of using Ambassador Animals to enhance delivery of these cognitive messages as well.

- MacMillen (1994) found that the use of live animals in a zoomobile outreach program significantly enhanced cognitive learning in a vertebrate classification unit for sixth grade students.
- Sherwood and his colleagues (1989) compared the use of live horseshoe crabs and sea stars to the use of dried specimens in an aquarium education program and demonstrated that students made the greatest cognitive gains when exposed to programs utilizing the live animals.
- Povey and Rios (2002) noted that in response to an open-ended survey question ("Before I saw this animal, I never realized that . . . "), visitors watching a presentation utilizing a Ambassador Animal provided 69% cognitive responses (i.e., something they learned) versus 9% made by visitors viewing the same animal in its exhibit (who primarily responded with observations).
- Povey (2002) recorded a marked difference in learning between visitors observing animals on exhibit versus being handled during informal presentations. Visitors to demonstrations utilizing a raven and radiated tortoises were able to answer questions correctly at a rate as much as eleven times higher than visitors to the exhibits.

Enhanced Environmental Attitudes

Ambassador Animals have been clearly demonstrated to increase affective learning and attitudinal change.

- Studies by Yerke and Burns (1991), and Davison and her colleagues (1993) evaluated the effect live animal shows had on visitor attitudes. Both found their shows successfully influenced attitudes about conservation and stewardship.
- Yerke and Burns (1993) also evaluated a live bird outreach program presented to Oregon fifth-graders and recorded a significant increase in students' environmental attitudes after the presentations.
- Sherwood and his colleagues (1989) found that students who handled live invertebrates in an education program demonstrated both short and long-term attitudinal changes as compared to those who only had exposure to dried specimens.
- Povey and Rios (2002) examined the role Ambassador Animals play in helping visitors develop positive feelings about the care and well-being of zoo animals.
- As observed by Wolf and Tymitz (1981), zoo visitors are deeply concerned with the welfare of zoo animals and desire evidence that they receive personalized care.

Conclusion

Creating positive impressions of aquarium and zoo animals, and wildlife in general, is crucial to the fundamental mission of zoological institutions. Although additional research will help us delve further into this area, the existing research supports the conclusion that Ambassador Animals are an important tool for conveying both cognitive and affective messages regarding animals and the need to conserve wildlife and wild places.

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Appendix G: Developing an Institutional Ambassador Animal Policy

Last revision 2003
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Rationale

Membership in AZA requires that an institution meet the AZA Accreditation Standards collectively developed by our professional colleagues. Standards guide all aspects of an institution's operations; however, the accreditation commission has asserted that ensuring that member institutions demonstrate the highest standards of animal care is a top priority. Another fundamental AZA criterion for membership is that education be affirmed as core to an institution's mission. All accredited public institutions are expected to develop a written education plan and to regularly evaluate program effectiveness.

The inclusion of animals (native, exotic, and domestic) in educational presentations, when done correctly, is a powerful tool. CEC's **Ambassador Animal Position Statement** describes the research underpinning the appropriate use of Ambassador Animals as an important and powerful educational tool that provides a variety of benefits to zoo and aquarium educators seeking to convey cognitive and affective messages about conservation and wildlife.

Ongoing research, such as AZA's Multi-Institutional Research Project (MIRP) and research conducted by individual AZA institutions will help zoo educators to determine whether the use of Ambassador Animals conveys intended and/or conflicting messages and to modify and improve programs accordingly and to ensure that all Ambassador Animals have the best possible welfare.

When utilizing Ambassador Animals our responsibility is to meet both our high standards of animal care and our educational goals. Additionally, as animal management professionals, we must critically address both the species' conservation needs and the welfare of the individual animal. Because "wild creatures differ endlessly," in their forms, needs, behavior, limitations and abilities (Conway, 1995), AZA, through its Animal Welfare Committee, has recently given the responsibility to develop taxon- and species-specific animal welfare standards and guidelines to the Taxon Advisory Groups (TAG) and Species Survival Plan® Program (SSP). Experts within each TAG or SSP, along with their education advisors, are charged with assessing all aspects of the taxons' and/or species' biological and social needs and developing Animal Care Manuals (ACMs) that include specifications concerning their use as Ambassador Animals.

However, even the most exacting standards cannot address the individual choices faced by each AZA institution. Therefore, each institution is required to develop an Ambassador Animal policy that articulates and evaluates program benefits. The following recommendations are offered to assist each institution in formulating its own Institutional Ambassador Animal Policy, which incorporates the AZA Ambassador Animal Policy and addresses the following matters.

The Policy Development Process

Within each institution, key stakeholders should be included in the development of that institution's policy, including, but not limited to representatives from:

- The Education Department
- The Animal Husbandry Department
- The Veterinary and Animal Health Department
- The Conservation & Science Department
- The Behavioral Husbandry Department
- Any animal show staff (if in a separate department)
- Departments that frequently request special Ambassador Animal situations (e.g., special events, development, marketing, zoo or aquarium society, administration)

Additionally, staff from all levels of the organization should be involved in this development (e.g., curators, keepers, education managers, interpreters, volunteer coordinators).

To develop a comprehensive Ambassador Animal Policy, we recommend that the following components be included:

I. Philosophy

In general, the position of the AZA is that the use of animals in up close and personal settings, including animal contact, can be extremely positive and powerful, as long as:

1. The use and setting is appropriate.
2. Animal and human welfare is considered at all times.
3. The animal is used in a respectful, safe manner and in a manner that does not misrepresent or degrade the animal.
4. A meaningful conservation message is an integral component. Read the AZA Board-approved Conservation Messages.
5. Suitable species and individual specimens are used.

Institutional Ambassador Animal policies should include a philosophical statement addressing the above, and should relate the use of Ambassador Animals to the institution's overall mission statement.

II. Appropriate Settings

The Ambassador Animal Policy should include a listing of all settings both on and off site, where Ambassador Animal use is permitted. This will clearly vary among institutions. Each institution's policy should include a comprehensive list of settings specific to that institution. Some institutions may have separate policies for each setting; others may address the various settings within the same policy. Examples of settings include:

1. On-site programming
    a. Informal and non-registrants:
        i. On-grounds programming with animals being brought out (demonstrations, lectures, parties, special events, and media)
        ii. Children's zoos and contact yards
        iii. Behind-the-scenes open houses
        iv. Shows
        v. Touch pools
    b. Formal (registration involved) and controlled settings
        i. School group programs
        i. Summer camps
        ii. Overnights
        iii. Birthday parties
        iv. Animal rides
        v. Public animal feeding programs
    c. Offsite and outreach
        i. PR events (TV, radio)
        ii. Fundraising events
        iii. Field programs involving the public
        iv. School visits
        v. Library visits
        vi. Nursing home visits (therapy)
        vii. Hospital visits
        viii. Senior centers
        ix. Civic group events

In some cases, policies will differ from setting to setting (e.g., on-site and off-site use with media). These settings should be addressed separately, and should reflect specific animal health issues, assessment of distress in these situations, limitations, and restrictions.

III. Compliance with Regulations

All AZA institutions housing mammals are regulated by the USDA's Animal Welfare Act. Other federal regulations, such as the Marine Mammal Protection Act, may apply. Additionally, many states, and some cities, have regulations that apply to animal contact situations. Similarly, all accredited institutions are bound by the AZA Code of Professional Ethics. It is expected that the Institution Ambassador Animal Policy address compliance with appropriate regulations and AZA Accreditation Standards.

IV. Collection Planning

AZA accredited institutions should have a collection planning process in place. Ambassador Animals are part of an institution's overall collection and must be included in the overall collection planning process. The AZA Guide to Accreditation contains specific requirements for the institution collection plan. For more information about collection planning in general, please see the Collection Management pages in the Members Only section.
The following recommendations apply to Ambassador Animals:

1. Listing of approved Ambassador Animals (to be periodically amended as collection changes). Justification of each species should be based upon criteria such as:
    a. Temperament and suitability for program use
    b. Husbandry requirements
    c. Husbandry expertise
    d. Veterinary issues and concerns
    e. Ease and means of acquisition / disposition according to the AZA code of ethics
    f. Educational value and intended conservation message
    g. Conservation Status
    h. Compliance with TAG and SSP guidelines and policies
2. General guidelines as to how each species (and, where necessary, for each individual) will be presented to the public, and in what settings
3. The collection planning section should reference the institution's acquisition and disposition policies.

V. Conservation Education Message
As noted in the AZA Accreditation Standards, if animal demonstrations are part of an institution's programs, an educational and conservation message must be an integral component. The Ambassador Animal Policy should address the specific messages related to the use of Ambassador Animals, as well as the need to be cautious about hidden or conflicting messages (e.g., "petting" an animal while stating verbally that it makes a poor pet). This section may include or reference the AZA Conservation Messages.
Although education value and messages should be part of the general collection planning process, this aspect is so critical to the use of Ambassador Animals that it deserves additional attention. In addition, it is highly recommended to encourage the use of biofacts in addition to or in place of the live animals. Whenever possible, evaluation of the effectiveness of presenting Ambassador Animals should be built into education programs.

VI. Human Health and Safety
The safety of our staff and the public is one of the greatest concerns in working with Ambassador Animals. Although extremely valuable as educational and affective experiences, contact with animals poses certain risks to the handler and the public. Therefore, the human health and safety section of the policy should address:

1. Minimization of the possibility of disease transfer from non-human animals to humans, and vice-versa (e.g., hand washing stations, no touch policies, use of hand sanitizer).
2. Safety issues related to handlers' personal attire and behavior (e.g., discourage or prohibit use of long earrings, perfume and cologne, not eating or drinking around animals, smoking, etc.).

AZA's Animal Contact Policy provides guidelines in this area; these guidelines were incorporated into accreditation standards in 1998.

VII. Animal Health and Welfare
Animal health and welfare are the highest priority of AZA accredited institutions. As a result, the Institutional Ambassador Animal Policy should make a strong statement on the importance of animal welfare. The policy should address:

1. General housing, husbandry, and animal health concerns (e.g. that the housing and husbandry for Ambassador Animals meets or exceeds general AZA standards and that the physical, social and psychological needs of the individual animal, such as adequate rest periods, provision of enrichment, visual cover, contact with conspecifics as appropriate, etc., are accommodated).
2. Where ever possible provide a choice for animal program participation, e.g., retreat areas for touch tanks or contact yards, evaluation of willingness/readiness to participate by handler, etc.)

3. The empowerment of handlers to make decisions related to animal health and welfare; such as withdrawing animals from a situation if safety or health is in danger of being compromised.
4. Requirements for supervision of contact areas and touch tanks by trained staff and volunteers.
5. Frequent evaluation of human / animal interactions to assess safety, health, welfare, etc.
6. Ensure that the level of health care for the Ambassador Animals is consistent with that of other animals in the collection.
7. Whenever possible, have a "cradle to grave" plan for each Ambassador Animal to ensure that the animal can be taken care of properly when not used as an Ambassador Animal anymore.
8. If lengthy "down" times in Ambassador Animal use occur, staff should ensure that animals accustomed to regular human interactions can still maintain such contact and receive the same level of care when not used in programs.

VIII. Taxon Specific Protocols

We encourage institutions to provide taxonomically specific protocols, either at the genus or species level, or the specimen, or individual, level. Some taxon-specific guidelines may affect the use of Ambassador Animals. To develop these, institutions refer to the Conservation Programs Database.

Taxon and species -specific protocols should address:

1. How to remove the individual animal from and return it to its permanent enclosure, including suggestions for operant conditioning training.
2. How to crate and transport animals.
3. Signs of stress, stress factors, distress and discomfort behaviors.

Situation specific handling protocols (e.g., whether or not animal is allowed to be touched by the public, and how to handle in such situations):

1. Guidelines for disinfecting surfaces, transport carriers, enclosures, etc. using environmentally safe chemicals and cleaners where possible.
2. Animal facts and conservation information.
3. Limitations and restrictions regarding ambient temperatures and or weather conditions.
4. Time limitations (including animal rotation and rest periods, as appropriate, duration of time each animal can participate, and restrictions on travel distances).
5. The number of trained personnel required to ensure the health and welfare of the animals, handlers and public.
6. The level of training and experience required for handling this species
7. Taxon/species-specific guidelines on animal health.
8. The use of hand lotions by program participants that might touch the animals

IX. Logistics: Managing the Program

The Institutional Policy should address a number of logistical issues related to Ambassador Animals, including:

1. Where and how the Ambassador Animal collection will be housed, including any quarantine and separation for animals used off-site.
2. Procedures for requesting animals, including the approval process and decision-making process.
3. Accurate documentation and availability of records, including procedures for documenting animal usage, animal behavior, and any other concerns that arise.

X. Staff Training

Thorough training for all handling staff (keepers, educators, and volunteers, and docents) is clearly critical. Staff training is such a large issue that many institutions may have separate training protocols and procedures. Specific training protocols can be included in the Institutional Ambassador Animal Policy or reference can be made that a separate training protocol exists.

It is recommended that the training section of the policy address:

1. Personnel authorized to handle and present animals.
2. Handling protocol during quarantine.

3. The process for training, qualifying and assessing handlers including who is authorized to train handlers.
4. The frequency of required re-training sessions for handlers.
5. Personnel authorized to train animals and training protocols.
6. The process for addressing substandard performance and noncompliance with established procedures.
7. Medical testing and vaccinations required for handlers (e.g., TB testing, tetanus shots, rabies vaccinations, routine fecal cultures, physical exams, etc.).
8. Training content (e.g., taxonomically specific protocols, natural history, relevant conservation education messages, presentation techniques, interpretive techniques, etc.).
9. Protocols to reduce disease transmission (e.g., zoonotic disease transmission, proper hygiene and hand washing requirements, as noted in AZA's Animal Contact Policy).
10. Procedures for reporting injuries to the animals, handling personnel or public.
11. Visitor management (e.g., ensuring visitors interact appropriately with animals, do not eat or drink around the animal, etc.).

XI. Review of Institutional Policies

All policies should be reviewed regularly. Accountability and ramifications of policy violations should be addressed as well (e.g., retraining, revocation of handling privileges, etc.). Institutional policies should address how frequently the Ambassador Animal Policy will be reviewed and revised, and how accountability will be maintained.

XII. TAG and SSP Recommendations

Following development of taxon-specific recommendations from each TAG and SSP, the institution policy should include a statement regarding compliance with these recommendations. If the institution chooses not to follow these specific recommendations, a brief statement providing rationale is recommended.