

**March 10, 2000**

**Prepared by Dr. Robert Wrigley, Member  
Conservation and Science Committee  
Canadian Association of Zoos and Aquariums**

## **CONSERVATION AND SCIENCE IN CANADA'S AQUARIUMS AND ZOOS**

**PREAMBLE**--The Canadian Association of Zoos and Aquariums was founded in 1975 to promote the welfare of zoo and aquarium wildlife, to advance related science and conservation, and to encourage public education and recreation. Among the Association's achievements in its first 25 years include an annual meeting, zoo accreditation, animal-husbandry standards, CAZA News, a Zoo Animal Technology Program, a web site, sponsorship of a Canadian Collection Plan, and the opening of a joint office in Ottawa with the Canadian Museum Association.

CAZA News, a new web site, and the annual meeting are the main avenues for distributing information to a membership scattered over great distances across the country. However, most conservation and research activities of Canada's aquariums, zoos, and related facilities are largely unknown beyond each organization. This is unfortunate, since there is an extensive, useful and interesting body of work conducted each year. Recognizing this problem, the Conservation and Science Committee of CAZA embarked on a project to gather, document and communicate these achievements for the period 1996 to 1999.

**PURPOSE**--The Conservation and Science Committee defined the following survey objectives:

- 1) set up a reference database on conservation and science initiatives of its membership, with the intention of disseminating these data on the CAZA web site,
- 2) advance the profile and reputation of CAZA and Canadian aquariums and zoos, and
- 3) prepare a summary useful as promotional support in dealing with governments and agencies.

**METHOD**--A letter was faxed or mailed to 112 institutional and individual members, requesting information on their conservation and science activities for the period of 1996 to 1999. At the request of the CAZA Board, a follow-up letter was sent to nine non-responding zoos on December 10, 1999. The total number of contacts included many individuals and dealers that do not operate a zoo/aquarium or maintain animals, but they potentially had information pertinent to this report. Twenty responses were returned, including both modest and large facilities and one individual.

While this response level may appear low, most major facilities did provide comprehensive summaries and annual reports. It was understood that certain questions were beyond the purview of many members' operations. Also, the task of answering yet another survey likely could not fit into all members' busy schedule. This survey represents the majority of Canadian aquarium/zoo accomplishments in science and conservation during the last four years, however some achievements have gone unrecorded here. CAZA member Marvin Jones, Registrar Emeritus of the San Diego Zoo, also kindly responded with some comments on the magnitude of research

conducted at this preeminent Zoo. The Conservation and Science Committee appreciates the efforts of those individuals that did manage to prepare and submit a report on their activities.

To assist in formulating both responses and this final report, information was requested under (although not restricted to) most of the headings listed below. Several topics, such as resource-conservation activities (e.g., waste reduction, pollution control) were not requested, but were noted in some reports. Project proposals, presentations at conferences, special meetings, and other events involving conservation and research were so numerous that they could not be incorporated into this report. Some submissions also listed numerous publications for certain years, but not always for the entire four-year period, and for the sake of brevity these have been omitted. These reports and papers often listed additional pertinent topics not mentioned in the body of the submissions. Conservation fund-raising and awards were also noted in some responses. The above topics are covered briefly in this report. Note that the important role of education was not surveyed.

### **Survey Categories**

- Conservation Committees (local to international)
- Species Survival Programs, Studbooks, and Special Interest Groups
- Canadian Collection Plan
- Habitat Research, Restoration and Preservation (natural and captive environments)
- Animal Population Surveys, Recovery Plans, and Release Projects
- Behavioral Research (under wild and captive conditions)
- Husbandry Research
- Veterinary Research
- Physiological, Reproductive, Morphological, Biochemical, and Genetic Research
- Nutritional Research
- Horticultural Research
- Registration and Data-management Research
- Taxonomic and Anthropologic Research
- Resource Conservation and Pollution Control
- Science and Conservation Awards and Fund-raising
- Publications, Technical Reports, and Conference Presentations

### **RESPONDENTS**

**African Lion Safari**, Cambridge, Ontario. James Dailley

**Aquarium du Quebec**, Sainte-Foy, Quebec. Dr. Robert Patenaude

**Assiniboine Park Zoo**, Winnipeg, Manitoba. Dr. Robert Wrigley and Dr. Gordon Glover

**Barrett Aviaries**, Qualicum Beach, British Columbia. Michael Barrett

**Biodome de Montreal**, Montreal, Quebec. Serge Pepin

**Bowmanville Zoo**, Bowmanville, Ontario. Michael Hackenberger

**Calgary Zoo**, Calgary, Alberta. Brian Keating and David Banks

**Crystal Garden**, Victoria, British Columbia. John Creviston

**Ecomuseum**, Sainte-Anne-de-Bellevue, Quebec. Dr. Roger Bider

**Jardin Zoologique de Granby**, Granby, Quebec. Dr. Clement Lanthier

**Jardin Zoologique du Quebec**, Charlesbourg, Quebec. Dr. Robert Patenaude

**Jungle Cat World**, Orono, Ontario. Robert Moyes  
**Kamloops Wildlife Park**, Kamloops, British Columbia. Dawn Brodie  
**Riverview Park and Zoo**, Peterborough, Ontario. Jack Sisson  
**Saskatoon Zoo**, Saskatoon, Saskatchewan. Barrie Meissner  
**Toronto Zoo**, Scarborough, Ontario. Dr. William Rapley  
**Valley Zoo**, Edmonton, Alberta. David Leeb and Sandy Helliker  
**Vancouver Aquarium**, Vancouver, British Columbia. Dr. Jeff Marliave and Trisha Hall  
**Zoo St-Felicien**, St-Felicien, Quebec. Patrick Pare

## **SURVEY RESULTS**

The large collection of information that was received presented quite a challenge in presentation for this report. I chose an abbreviated topic description and support agencies as most relevant, omitting authors, detailed findings, and other data. Specific enquiries about certain studies should be directed to the appropriate institution.

### **Conservation Committees (local to international)**

African Lion Safari: participates in International Association of Avian Trainers and Educators Conservation Committee.

Assiniboine Park Zoo: participates on the Manitoba Natural Resources Endangered Species Advisory Committee, which has reviewed or is considering 122 species and has recommended the listing of 39 species at risk; participates on the Manitoba Natural Resources Ecological Reserves Committee, which is considering 50 candidate sites and has designated 16 ecological reserves -- the highest provincial level of ecosystem protection; participates on the Scientific Advisory Committee of the Nature Conservancy of Canada, Manitoba Office.

Calgary Zoo: participates as a member of the Conservation Breeding Specialist Group of the International Union for the Conservation of Nature (IUCN), which conducts ecosystem assessments and related workshops; leading role in Environmental and Outdoor Education Council of Alberta by coordinating a newsletter and by organizing an annual conference for 3500 members, and other professional meetings where conservation issues are considered.

Ecomuseum: represented on a recovery program for the threatened Eastern Spiny Soft-shelled Turtle and Western Chorus Frog.

Jardin Zoologique de Granby: scientific advisor to le Ministere de l'environnement et de la faune du Quebec, regarding species at risk.

Toronto Zoo: numerous staff cooperate with the Conservation Breeding Specialist Group of the International Union for the Conservation of Nature (IUCN); member is on the Board of the Canadian Organization for Tropical Education and Rainforest Conservation; coordinated a symposium on Human Aspects of Turtles in Trade and Food Products; member serves on the Wildlife Conservation Management Committee that reviews all conservation programs of the American Zoo and Aquarium Association.

### **Species Survival Programs (SSP and EEP), Studbooks, and CITES-listed Species**

A Species Survival Plan (SSP) is a North American breeding-management plan, operated by the American Zoo and Aquarium Association (AZA), and based on genealogies of captive individuals of species at risk. The European Endangered Species Plan (EEP) is the European equivalent. A Studbook is a multi-facility record of genetically valued specimens of a species,

including individual genealogies and locations, which is used for managing captive populations. A Population Management Plan (PMP) is also a breeding plan for certain species, operated by AZA. The Convention on the International Trade in Endangered Species of Wild Fauna and Flora (CITES) is an international conservation agreement created by the International Union for the Conservation of Nature (IUCN), which controls the trade of listed at-risk plants and animals (and their parts) across international borders.

African Lion Safari: participates in 5 SSPs and Studbooks, and 3 Rare Breeds Registries.

Assiniboine Park Zoo: 17 SSPs, 1 EEP and 33 species' Studbooks; holds 26 species on CITES Appendix I and 63 species on Appendix II.

Biodome de Montreal: 3 SSPs (marmoset and tamarins); 10 species' Studbooks.

Calgary Zoo: 20 SSPs; Studbook Keeper is collecting data on Alpine Ibex for a revised Studbook.

Crystal Garden: SSPs for Pygmy Loris, Bali Mynah, Golden Lion Tamarin, Ring-tailed Lemur, and Ruffed Lemur, and applying for 3 other SSP species; 8 Studbooks and plans for 2 others; also maintain other endangered species such as Spider Tortoise, Buffon's Macaw, and 4 species of Madagascar fish.

Jardin Zoologique de Granby: 12 SSPs and 60 species' Studbooks; North American Regional Polar Bear Studbook Keeper; 11 species' Taxon Advisory Groups (TAGs).

Jungle Cat World: Snow Leopard SSP, and Studbooks and PMPs for the Amur and Chinese leopards, Caracal, Ocelot, and Sand Cat.

Riverview Park and Zoo: SSPs for Red Panda and Black and White Colobus Monkey.

Saskatoon Zoo: has applied for participation in the Tiger SSP.

Toronto Zoo: 24 SSPs and 91 species' Studbooks and PMPs; five curatorial staff are on committees of Taxon Advisory Groups (TAGs), Scientific Advisory Groups (SAGs), Faunal Interest Groups (FIGs), and the Wildlife Conservation Management Committee (WCMC) -- all directed by the American Zoo and Aquarium Association.

Valley Zoo: 5 SSPs, numerous studbook programs; breeds 23 CITES species.

### **Canadian Collection Plan**

Now in its formative stage, this plan's objectives are rationalizing and managing zoo and aquarium animal collections within Canada. Priority is directed to species that are endangered or threatened (particularly if native to Canada), and that demonstrate interpretive and recreational values. From a complete inventory of captive populations of the major animals groups, certain species will be selected for transfer and propagation. Most Canadian zoos and aquariums will be participating in the future.

Assiniboine Park Zoo: applying rating system to bird species.

Cherry Brook Zoo: rating the primates.

Crystal Garden: participating in this plan.

Riverview Park and Zoo: representative on the CCP Advisory Group.

Toronto Zoo: coordinating the development of this new plan, and rating mammals, reptiles and amphibians.

Valley Zoo: participating in this plan.

### **Habitat Research, Restoration and Preservation (natural and captive environments)**

Assiniboine Park Zoo: advises Manitoba Government on sites throughout the province worthy of being designated as Ecological Reserves, due to their biological and landscape values.

Biodome de Montreal: conservation and restoration of threatened and vulnerable plants in Quebec and Ontario (with le Ministere Environment et Faune du Quebec, Quebec Natural Resources, Environment Canada); effects of the litters of various tree species on the nutrient cycle in mixed boreal forest (with Natural Sciences and Engineering Research Council of Canada); growth, mineral nutrition, and survival of successional trees in degraded soil in Ecuadorean Amazonia; effects of light on growth of tropical tree seedlings; reforestation of fragile environments contributing aquatic mercury contamination in the Brazilian Amazon; conservation biology of threatened and vulnerable plants; reforestation with hardwoods in Quebec; impacts of land uses on soils in tropics; conservation and restoration of Ginseng, Green Dragon, and Wild Leek in Canada; population dynamics of Ginseng in the southern Appalachians (with United States National Park Service); role of meiofauna on organic-matter mineralization and nitrification in cold marine ecosystems; phytoplankton succession, biomass and diversity in a marine aquarium; study of unicellular benthic and planktonic algae in marine waters of the Gulf of St. Lawrence; soil-moisture effects on the growth of endangered endemic plants of dry-scrub in Florida (with Archbold Biological Station).

Calgary Zoo: Master Gardener Volunteer Program, which conducts plant rescues and habitat restoration; Schoolyard Naturalization Program, which assists 15 local schools in planting gardens and habitats that attract wildlife; partnership with the Nature Conservancy of Canada to conserve habitats and to recruit new member support.

Jungle Cat World: planned and developed enclosures with special landscaping features designed to stimulate natural behavior and to reduce problematic habits in the Cougar, Jaguar and Amur Leopard.

Riverview Park and Zoo: riverbank erosion-control program to reduce impact of pedestrian traffic and river flow, and to encourage fish habitat in the Otonabee River.

Toronto Zoo: survey assisting in the creation of a sanctuary for the Hippopotamus in Ghana; habitat use of the Snapping Turtle in the Rouge River and Lake Ontario; assessment of natural ecosystems within the zoo grounds, and planting trees and shrubs; wetland restoration and butterfly-meadow creation; examination of oak-savanna habitat of the Karner Blue Butterfly; restoration of the Morningside Tributary of the Rouge River, Ontario; Red Mulberry Recovery Project; member of an international team assessing habitat of the Komodo Dragon in Indonesia; liaison with visiting scientist from Ugandan Fish Research Institute.

Valley Zoo: exhibit enhancement by naturalizing current displays (over ten completed).

Vancouver Aquarium: 'River Works' Program involved staff and 492 volunteers (from nine environmental organizations, three companies, and five school groups), and monitored and restored six sites along the Fraser River; surveyed and inventoried estuarine biota, cleaned up debris, and conducted water-quality tests in ten marshes in the Fraser River Delta.

Zoo St-Felicien: studied the use of exhibit design, landscape structure, and other factors in attracting animals into public view in large enclosures.

### **Animal Population Surveys, Recovery Plans, and Release Projects**

African Lion Safari: release of 7 Trumpeter Swans at Fair Lake, Ontario (with Ontario Trumpeter Swan Restoration Program); release of captive-bred Barn Owls, and feasibility study of release sites in southern Ontario; release of juvenile Bald Eagle in Missouri (with Fish and Wildlife

Department of Missouri, USA); release of juvenile Ferruginous Hawks in Manitoba (with Manitoba Natural Resources); release of juvenile Burrowing Owls in Manitoba and Alberta (with Manitoba Natural Resources and Alberta Forestry, Lands and Wildlife); rehabilitation of injured and orphaned mammals and raptors, and release when possible.

Aquarium du Quebec: operates a stranded-seal recovery centre for the St. Lawrence estuary (with Fisheries and Oceans Canada); movement and migration of tagged fish in the St. Lawrence (with Environment Canada).

Assiniboine Park Zoo: field survey of tiger beetles at risk; co-authoring book on the 'Tiger Beetles of Manitoba'; found zoo homes for numerous native species of orphaned or unreleaseable birds (including 12 Bald Eagles) and mammals; supplied biological samples for research on Bushdog ecology in Paraguay (by student at Kansas State University).

Barrett Aviaries: participated in census of captive *Branta sandvicensis*, *Tragopan blythi* and *T. caboti* within the United States (with the American Pheasant and Waterfowl Society).

Biodome de Montreal: impact of agriculture on the home range and movements of the vulnerable Wood Turtle in Quebec; bat-box program (with the Toronto Zoo); role of invertebrate fauna in the decomposition process of different litters in the mixed boreal forest; inventory of meiofauna populations in cold marine waters of the Gulf of St. Lawrence; study of copepods (Crustacea) of the British Isles and North Atlantic; survey of Springtails (invertebrates) in the soil and litter of a Sugar Maple forest (by student at UQAM); diversity of copepods in mangrove forests of Tanzania.

Bowmanville Zoo: Reintroduction of large carnivores to managed wild areas in South Africa.

Calgary Zoo: The Zoo's Devonian Wildlife Conservation Centre directs a number of endangered species recovery initiatives, such as the breeding and release of the endangered Vancouver Island Marmot (with the Toronto Zoo and the VIM Recovery Team); population and habitat viability for the Eastern Slopes Grizzly Bear, and managing bear-people interactions (with the Conservation Breeding Specialist Group); population and habitat-viability assessment for the Peary race of Caribou in Yellowknife, Northwest Territories (with other agencies); status and distribution of the Gray Wolf in Alberta, with reference to cattle predation; Tree Kangaroo field research in Papua New Guinea; Osprey nest-monitoring and banding (with local electrical company); development of a DNA technique for identifying Gorilla by shed hair, to be used as a census technique in the wild (with student from University of Calgary); assisted with research team studying Whooping Crane chick survivability (with Canadian Wildlife Service).

Ecomuseum: collects and compiles data for a 'Quebec Atlas of Amphibians and Reptiles'; coordinates the Quebec Frog-call Monitoring Program; field research on Eastern Spiny Soft-shelled Turtle populations, including radio-tagging the turtles in the Missisquoi River (with the Vermont Fish and Wildlife Service); determined the provincial status and nesting ecology of the Wood Turtle (with provincial and federal agencies and students at the universities of McGill and Quebec); conducted surveys on the Northern Brown Snake (with le Ministere Parc et Faune), and preserved snake habitat sites near the Ecomuseum; designed a herpetology-survey program for parks of the Montreal Urban Community.

Jardin Zoologique de Granby: habitat and movement patterns of adult Walrus in the High Arctic (with Department of Fisheries and Oceans); field research involving capture and radio-tagging the Eastern Spiny Soft-shelled Turtle.

Jungle Cat World: developed on-line animal-adoption program with Endangered Species Fund of Canada.

Kamloops Wildlife Park: Breeds and releases several dozen, tagged, endangered Burrowing Owls annually.

Toronto Zoo: Vancouver Island Marmot captive-breeding and release program; monitoring population of Cricket Frog on Pelee Island, Lake Erie; Eastern Massasauga Rattlesnake Habitat Symposium, newsletter and web site; Toronto Herpetofauna Inventory and Guide Project; Puerto Rican Crested Toad Breeding and Release Program; examination of alternatives for disposition of non-native Red-eared Slider Turtle; bioinventory and aquatic analysis of the Morningside Tributary of the Rouge River, especially for the endangered Redside Dace; breeding and release of Redside Dace; breeding and reintroduction of the Desert Pupfish; Trumpeter Swan reintroduction and migration; control measures for urban Canada Geese; participates in annual butterfly survey (with North American Butterfly Association); collection and study of Vietnamese invertebrates (with Centre of Biodiversity of the Royal Ontario Museum); see Husbandry section for species being bred for future release; research on capturing Narwhals at Resolute Bay for applications of radiotelemetry and cameras (with a Danish research institute).

Valley Zoo: released 27 zoo-born Swift Fox over an 8-year period as part of a project to re-establish the species in Alberta (with Canadian Wildlife Service); finds homes for or releases (after rehabilitation) annually about 200 orphaned or injured birds and mammals; published "Mother Nature is Looking After Me," to inform people not to disturb young wildlife.

Vancouver Aquarium: launch of ORCA-FM (part of WhaleLink Program) -- the world's first all-whale FM broadcast station, which monitors sounds of whales along the British Columbia coast, allowing the recognition of dialects of resident pods and their movements; photo-identification census of 700 Killer Whales to determine productivity and survivorship; survey and photo-identification of the increasing population (400 individuals) of Humpback Whales in waters off Langara Island, Queen Charlotte Islands; monitoring and natural-history studies of marine life in the Howe Sound, with special reference to resources for Lingcod stocks; annual Lingcod Egg-Mass Survey, and tagging and movement study; observation and videotaping of Boot Sponges; survey of juvenile prawns (two species) and their Agarum Kelp habitat at Grace Islets and Columbine Bay; transplant Rockfish at Point Atkinson; Herring Cruise and dives to investigate larval herring and other co-inhabitant fishes on British Columbia reefs; biology of diving ducks, especially Surf Scoter (with Canadian Wildlife Service); use of new diver-operated plankton net for Herring and other plankton surveys along underwater cliff faces (supported by Howe Sound Research and Conservation Group).

Zoo St-Felicien: survey of the Eastern Cougar in Quebec through infra-red photography and attraction with urine pheromones from captive cougars (with Envirotel, Zoo de Granby, et le Ministère Environment et Faune du Quebec).

### **Behavioral Research (under wild and captive conditions)**

African Lion Safari: research on 'musth' in Asian Elephant since 1988; breeding behavior of macaws (by student of University of Waterloo); handedness in macaws (by student at Sault College of Applied Arts and Technology); olfactory detection of food by the Turkey Vulture (by student at University of Guelph); avian intelligence (by professor at McMaster University).

Assiniboine Park Zoo: cooperated with University of Winnipeg on a 15-year analysis of social behavior in three captive colonies (65 individuals) of Lion-tailed Macaque; about 20 University of Manitoba zoology students come annually to investigate and report on zoo-animal behavior (e.g., Aggression in American Flamingos and the 'Selfish Herd', Hand Preference in Two

Species of Captive Gibbon, Anti-predator Responses of the Black-tailed Prairie Dog); Brandon University professor directed several students' projects in primate behavior; visiting University of Calgary student filmed and studied carnivore chewing mechanisms; study and recording of pecking sounds of Pileated Woodpecker in relation to developing a sound-deterrent to prevent the bird's destruction of wooden power-line poles (by consultant contracted by Manitoba Hydro).

Calgary Zoo: Woodland Caribou taste-avoidance testing in relation to highway mortality; behavior of free-ranging ex-captive Orangutan (by student of University of Calgary); behavior of the Redtail Monkey in Uganda's Budongo Forest Reserve (by student of University of Calgary); vocal learning and behavior in the Chimpanzee population of the Budongo Forest, Uganda; feeding behavior of wild and captive Whooping Cranes; development of breeding behavior in juvenile Whooping Crane.

Jardin Zoologique de Granby: vocalization of the Western Lowland Gorilla (with York University).

Jardin Zoologique du Quebec: effects of enrichment techniques on behavior of adult Chimpanzee.

Toronto Zoo: assessment of an elephant protected-contact protocol on social behavior within the elephant group; behavioral predictors of estrus in Indian and Sumatran Rhinos; effects of enrichment (e.g., on burrowing and locational memory) on Black-footed Ferrets; behavior of Olive Baboons introduced to new surroundings; effects of behavioral enrichment on, and vocalization in, the Vancouver Island Marmot and Lowland Gorilla; visual acuity of camels (with University of Western Ontario and York University); behavioral enrichment using foraging devices for the Saki Monkey.

Vancouver Aquarium: behavior, communication, life history and ecology of marine mammals, particularly Killer Whale; acoustic studies have led to 'Whale Link', which involves remote acoustical monitoring of the Killer Whale along the British Columbia coastline; ability of aquarium Beluga to resolve their own sounds amid background noise (with University of British Columbia and Department of Fisheries and Oceans); evolution of Killer Whale dialects (with student of University of British Columbia); the use of ice as a reinforcer in maintaining behavioral control of the Steller Sea Lion during fasting experiments.

Zoo St-Felicien: changes in dominance, enclosure utilization, activity budgets, and social behavior within a 12-member pack of Gray Wolf (with l'Universite du Quebec a Chicoutimi); enrichment research on three species of bears, Cougar and Chimpanzee.

### **Husbandry Research**

African Lion Safari: design and building supervision of breeding chambers for Palm Cockatoos in Java, Indonesia; trained Indonesians with handling techniques for captive and wild birds; identification and handling techniques and clinics (for Ontario Human Societies, University of Guelph Wild Bird Clinic, Ontario Natural Resources, United States Fish and Wildlife Service); designed breeding chambers for easy examination of nestling macaws, Golden Eagle, Bald Eagle, Gyrfalcon and Peregrine.

Aquarium du Quebec: breeding and management of seahorses in aquaria (with McGill University and Zoological Society of London); participation, through maintenance and breeding protocol, in the Copper Redhorse (endangered fish) Conservation Committee in Quebec; husbandry techniques for jellyfish and exchange of data (with Florida Aquarium); testing of filtration equipment to maintain live corals.

Assiniboine Park Zoo: advised Manitoba Natural Resources in the preparation of detailed facility guidelines and an application procedure for aquariums/zoo's wishing to receive orphaned wild polar bears; preparation of revised husbandry standards for all sections of the zoo; contribute information to CAZA husbandry standards; development of a new Dangerous-Animal Escape Policy; fly control in animal enclosures; cockroach control in a tropical house.

Barrett Aviaries: hand-feeding protocol and cooperative breeding program for Crowned Pigeons (with American Pheasant and Waterfowl Society); Ocellated Turkey breeding program.

Biodome de Montreal: survey of parameters governing utilization of bat houses (with Toronto Zoo); distribution and abundance of Giant Toad in a tropical forest exhibit; sea-water denitrification in the St. Lawrence aquarium exhibit; nitrogen budget as a management tool for a closed aquatic ecosystem; production-biomass ratio of copepods in sand filters of aquarium exhibits.

Calgary Zoo: assisted Cuba's Havana Zoo and Guyana's Georgetown Zoo with master plan and husbandry advice; study of the effects of medication, enclosure structure, varied feeding schedule, and diet on stereotypic behavior of the Polar Bear (with University of Calgary); breeding behavior of Whooping Crane.

Toronto Zoo: developed an AZA husbandry manual for the Puerto Rican Crested Toad; protocols for breeding endangered Vancouver Island Marmot, Black-footed Ferret, Loggerhead Shrike, Karner Blue Butterfly, and tarantula species; protocol for captive management of seahorses; survey of parameters governing utilization of bat houses.

Vancouver Aquarium: husbandry protocols for over 12 species of marine fishes and five species of shrimps (with the Howe Sound Research and Conservation Group); new water-quality monitoring and evaluation techniques for aquatic-exhibit systems.

Zoo St-Felicien: using refrigeration to simulate hibernation in frogs (with student from CEGEP St-Felicien); research in maintaining multiple-species exhibits for carnivores (River Otter, Red Fox, Raccoon, Striped Skunk, American Marten all together), herbivores and omnivores (Bison, Elk, White-tailed Deer, Black Bear, Bighorn Sheep, Mountain Goat and Prairie Dog all together); and Snowshoe Hare, Beaver, Porcupine, Muskrat, Woodchuck, and waterfowl all together); husbandry parameters influencing reproduction in captive Wolverine (with le Ministere Environnement et Faune du Quebec, and the Canadian Wildlife Service); establishing a new Great Blue Heron heronry from a wild population in the Saguenay-Lac-St-Jean area, by translocating young birds to artificial nests at the Zoo (with le Ministere Environnement et Faune du Quebec).

### **Veterinary Research**

African Lion Safari: provided blood samples of Asian Elephant for study of elephant Herpes Virus (with National Zoo, Washington, USA); trained Indonesians with use of medications for captive and wild birds.

Aquarium du Quebec: study on the state of health of fish in the St. Lawrence River (with Environment Canada and Faculty of Veterinary Medicine, University of Montreal).

Assiniboine Park Zoo: control procedures for Anthrax, Rabies and *Geopetitia aspiculata* infections; assisted Health Canada with field investigation of Tularaemia at the Zoo; offered practicum experience for vet student from St. Hyacinth Veterinary College, Quebec; assisted study of cat retroviruses (by University of Manitoba); assisting with research project on *Parelaphostrongylus odocoilei* in wild Stone's and Dall Sheep (by Western College of Veterinary Medicine, University of Saskatchewan); involved in a clinical study of a vaccine for

the prevention of neonatal diarrhea in ruminant species; effects of medication on seizures in Grey Gibbon.

Bowmanville Zoo : Ibuprofen uptake and response by African and Asian elephants; semen collection in Asian and African elephants as part of an international artificial insemination effort.

Calgary Zoo: investigation of the causes of mortality in free-ranging Swift Fox; the occurrence of the Schistosomiasis blood fluke in Chilean Flamingo; chick survivability in wild Whooping Crane in Wood Buffalo National Park.

Jardin Zoologique de Granby: anaesthetic drug studies on Grey Seal (with University of Saskatchewan, Saskatoon, and Fisheries and Oceans Canada); study of red blood cell membranes of Jamaican Fruit Bat (by graduate student from Bishop's University); reversible anaesthesia of Atlantic Walrus.

Jardin Zoologique du Quebec: raptor surgical rehabilitation (with the Raptor Clinic of Montreal School of Veterinary Medicine); cancer in Golden Eagle; echographic imaging of the small intestine in the Tiger; relative efficiency of tranquillizing drugs for free-ranging Moose; tumors in wild Raccoons living in a suburban habitat.

Saskatoon Zoo: association with the Western College of Veterinary Medicine, allowing access of staff and students to the animal collection; preparation of policy outlining the types of research protocols acceptable for the animal collection.

Toronto Zoo: developing technology for embryo collection through estrus synchronization using progesterone implants in Wood Bison; treatment of *Cryptosporidiosis* parasite in captive reptiles; study of lipid metabolism and associated disease in amphibians; investigation of the disease *Mycobacteriosis* in Pupfish; investigating numerous factors (e.g., nutrition, reproductive history) potentially linked to cancer in Black-footed Ferrets -- the major cause of mortality in captive populations; mock outbreak of disease in free-ranging wildlife and its implications for a zoo collection; electronic implants; tuberculosis in the Bongo.

Valley Zoo: investigating progesterone levels in Asian Elephant in relation to estrus; researching contraceptive implants.

Vancouver Aquarium: reduction of dental disease in northern Sea Otters through new oral hygiene practices; risk analysis for potential fungal disease in Beluga; development of a new contraceptive approach for Killer Whale.

Zoo St-Felicien: prevention of infection by Meningeal Worm (*Parelaphostrongylus tenuis*) of a caribou herd by means of snail-proof fence and sand barriers, separating an enclosure of White-tailed Deer carriers.

### **Physiological, Reproductive, Morphological, Biochemical, and Genetic Research**

African Lion Safari: eye structure of raptors (by professor at University of Waterloo); preservation of Asian Elephant semen; artificial insemination of Asian Elephants (with National Zoo, Washington, USA); made available Asian Elephants for ultrasonography of reproductive tracts; provided blood samples for a prenatal sex-determination study (with Dickerson Park Zoo, Springfield, Missouri); perfected artificial-insemination techniques for falcons (with University of Guelph, Poultry Sciences); manipulation of environment to stimulate breeding cycles in psittacines, leading to successful breeding of Scarlet, Military, Buffon's, and Green-winged macaws.

Assiniboine Park Zoo: provided biological samples for DNA projects on Bushdog (Kansas State University) and Markhor (Brookfield Zoo); assisted University of Calgary student with filming

chewing mechanics of carnivores; provided samples of Polar Bear faeces for a study of cortisol levels as a potential indicator of stress from ecotourism in wild bears at Churchill, Manitoba (by student at University of Manitoba).

Biodome de Montreal: artificial reproduction of the endangered Copper Redhorse (fish) endemic to Quebec, and habitat preference of fry (by student of UQAM); physiological and behavioral adaptations in response to energy and nitrogen requirements of three species of tropical bats; food-selection studies in three species of tropical bats; identification key of eggs of threatened turtles of Quebec .

Bowmanville Zoo: cadmium uptake by Caribou; bioenergetics and nitrogen balances of African and Asian elephants.

Calgary Zoo: investigation of Porcine zona pellucida (an injectable drug manufactured from pig ovary protein) as an immune-stimulated contraceptive in large mammals;

Jardin Zoologique de Granby: researching cellular receptors for measles virus (with Amgen and Ontario Cancer Institute); study of red blood cell membranes of Jamaican Fruit Bat (by graduate student from Bishop's University); reproductive hormones in faeces of North American Porcupine (by student at City University of New York at Queens College); winter bioenergetics of Porcupine (with student from University of Sherbrooke); immunotoxicology of Grey Seal (by l'Universite du Quebec); retroposition and evolution of mammalian genome using blood of the Jamaican Fruit Bat (study involving three Quebec medical institutions); neuroanatomy of Gorilla (by McGill University); agenesis of a radius in a Polar Bear cub.

Jardin Zoologique du Quebec: prediction and annual variation of body composition, reproductive hormones, and blood constituents in Red Fox.

Toronto Zoo: evaluation of reproductive function from urine and faecal samples in over ten mammalian species (including killer whale and Tasmanian devil) from Toronto, Calgary, Vancouver, and Bowmanville zoos, and Vancouver Aquarium; canine reproductive studies involving artificial insemination, gamete freezing, genome resource bank, and cycle- and pregnancy-status determination through semen and faeces (e.g., Red Wolf SSP, in cooperation with several United States agencies and zoos); behavioral patterns of Black-footed Ferrets, with special attention to indicators of ovulation and pregnancy (based on 800 hours of videotape); develop a DNA-based method of assessing genetic variation in wild populations of Marbled Murrelet (seabird); analysis of blood chemistry and cell counts to compare healthy and diseased amphibians.

Valley Zoo: participated in physiological survey of captive primates.

Vancouver Aquarium: population genetics of the Killer Whale with a focus on population structure and mating patterns through DNA analyses (with student of University of British Columbia); metabolic rates and thermoregulation of Steller Sea Lion; biomechanics of swimming in Steller Sea Lion; bioenergetic modelling under different environmental and life-history conditions (by student of University of British Columbia).

Zoo St-Felicien: participated in the recovery plan for the Wolverine in eastern Canada by researching reproduction in captive animals (with le Ministere Environment et Faune du Quebec); predicting growth and symmetry of moose antlers in relation to age and nutrition (with l'Universite du Quebec a Chicoutimi); investigation of inbreeding in the Gray Wolf by means of blood analysis (20 years of breeding with three founders); comparison and measurement of skeletal material of Muskox and Polar Bear in relation to Arctic adaptations; bullfrog hibernation

in refrigerated water (with CEGEP de St-Felicien); a review of the spiral in Nature and its incorporation into plant and animal design.

### **Nutritional Research**

African Lion Safari: provided Asian Elephant milk to Globber for analysis and subsequent production of a powdered milk formula for elephants, now available worldwide.

Assiniboine Park Zoo: review and revise all animal diets, incorporating new products; survey of zoo diets for edentate mammals (sloths and tamanduas).

Biodome de Montreal: food choices of pollen and nectar of a captive fruit bat colony (*Glossophaga soricina*) in a tropical-forest exhibit.

Calgary Zoo: assessment of nutrient utilization by captive felines (with Toronto Zoo).

Jardin Zoologique de Granby: practical guide to the diets of terrestrial mammals, seals, amphibians, and reptiles of Quebec.

Toronto Zoo: dietary requirements (related to fatty acids and hibernation) of the Vancouver Island Marmot; digestibility of primate diets for Red Panda; evaluation of alternative diets on nutrient utilization and dental effects in captive felines; nutrition of the Tamandua; effects of diet on growth of Puerto Rican Crested Toad tadpoles; nutritional value of invertebrates (mainly insects) as food for the animal collection; effect of freezer storage on nutritional value of fish used to feed birds and mammals.

Vancouver Aquarium: nutritional energetics (e.g., dietary efficiency, effects of changing prey, relationship of growth and diet) of Steller Sea Lion in light of serious declines in Alaskan populations (with University of British Columbia and other members of the North Pacific Universities Marine Mammal Consortium); 20-year study of the diet of resident and transient Killer Whales.

Zoo St-Felicien: research Eucalyptus-leaf substitutes (e.g., red oak and raspberry) for the diet of walking stick insects (with student from CEGEP de St-Felicien); nutrition (i.e., fruit flies and crickets) during growth stages of the life cycle of the Chinese Mantid (with student from CEGEP de St-Felicien); effects of nutrition on the growth of captive and wild Caribou in northern Quebec, with reference to declines in wild Caribou, possibly related to range degradation by large herds (with student from l'Universite de Laval and le Ministere Environment et Faune du Quebec); development of an aquatic plant-based pelletized food, with anti-inflammatory and anti-diarrhea properties, for captive Moose; comparison of growth and cost factors of various commercial milk products for feeding young Moose.

### **Horticultural Research**

Assiniboine Park Zoo: Purple Loosestrife eradication program.

Biodome de Montreal: developed a propagation program for 150 species of native plants (including Ginseng and Wild Leek) for use in the Laurentian Forest exhibit; Ginseng reproduction by somatic embryogenesis, and woodland cultivation.

Toronto Zoo: eradication of Purple Loosestrife; creation of wetland habitats and butterfly meadows; Red Mulberry Recovery Project.

Valley Zoo: short-grass prairie restoration program on zoo grounds and the Prairie Dog exhibit.

Zoo St-Felicien: regeneration of a mixed forest in a large animal enclosure (attempting to increase deciduous species in a 325-hectare forest with moose and other browsers).

### **Registration and Data-management Research**

A number of Canadian zoos participate in the International Species Information System (ISIS), which maintains computerized census records on captive wildlife on a worldwide basis by means of the ISIS program -- Animal Record Keeping System (ARKS).

Aquarium de Quebec: updating its animal files on a new system.

Assiniboine Park Zoo: entered 10,000 historical (back to 1905) animal records into ARKS.

Calgary Zoo: development of new web site outlining conservation programs.

Toronto Zoo: participant in ISIS since 1974; incorporating data from the Medical Animal Record Keeping System (Med-ARKS) into the BIOCON program to provide reference for blood samples.

Vancouver Aquarium: installation of on-line monitoring of aquatic-exhibit systems; completion of fish transactions into ARKS 3.0.9, and MedARKS; preparing to work on ARKS 4.0, which allows entry of invertebrates; planning for year-2000 operation of a 'new marine-mammal, electronic-database system,' using touch-screen technology.

### **Taxonomic and Anthropologic Research**

Assiniboine Park Zoo: donates carcasses of zoo animals to the Manitoba Museum and Anthropology Department of the University of Manitoba for archaeological identification, displays, and taxonomic research; study on dying and death of zoo animals-- the effect on the public, and the disposition of the remains (with Department of Geography, University of Manitoba).

Biodome de Montreal: discovery of new species of Springtail (invertebrate) in Sugar Maple forests of Quebec (by student of UQAM, with Canadian Forestry Service, and le Ministere Environnement et Faune du Quebec); discovery of a new species of predatory marine mite in a Biodome aquarium; taxonomy of copepods (Crustacea) in the Baltic Sea.

Vancouver Aquarium: described larval forms of marine fishes and shrimps.

Zoo St-Felicien: comparison of glues (using moose skin, fat, and fir resin) as a binder for paintings completed on birch bark by 18th-Century Aboriginal People (with student from CEGEP de St-Felicien).

### **Resource Conservation and Pollution Control**

Assiniboine Park Zoo: recycles office, metal and plastic wastes.

Biodome de Montreal: studies on mercury exposure and ecosystem health in the Amazon (with International Development Research Centre).

Riverview Park and Zoo: minimizing use of pesticides and using alternate turf-maintenance practises; contract with local farmers to spread natural zoo wastes on agricultural land.

Toronto Zoo: achieved 34% reduction in landfill; waste and recyclable operations are increasingly efficient; retrofitting fluorescent lights with T-8 lights have resulted in substantial energy and financial savings; CFC Elimination Plan is underway in refrigerant equipment; undertook Environmental Management and Audit System Plan; participates in City Smog Alert Plan; Hazardous Materials and Pesticides Use policies are been reviewed and revised.

Valley Zoo: composts all appropriate wastes from animals and zoo operation; recycles metal and paper.

Vancouver Aquarium: ‘Great BC Beach Clean Up’ involved over 1400 volunteers from 70 community groups, who cleaned up 80 kilometres of beach at 70 sites (with support of Canada Trust and the Friends of the Environment Foundation).

Zoo St-Felicien: uses an artificial marsh to cleanse waste water; recycles paper; composts all appropriate animal wastes.

### **Science and Conservation Awards and Fund-raising**

Assiniboine Park Zoo: “Save the Rhino Fund” contributions by the APZ Zookeepers Association.

Biodome de Montreal: research funding is obtained from Fondation de la Faune du Quebec, Ministere Environment et Faune du Quebec, Ministry of Natural Resources of Quebec, Environment Canada, International Development Research Centre, and Conseil des recherches en Peches et Agro-alimentaire de Quebec; 13 grants received for research on various aspects of forest ecology; grants for research on marine life, Wood Turtle, and Bat Boxes.

Calgary Zoo: Conservation Fund contributions towards study of Grizzly Bear in the Canadian Rockies; to the Snow Leopard Trust; to Gray Wolf-cattle predation research; to Lion Tamarin field work and reintroduction in Brazil; to Jane Goodall Institute of Canada for an enclosure for 71 orphaned chimps at the relocated facility; to Diane Fossey Gorilla Fund International to help support protection of the Gorilla; to Charles Louis Davis, DVM Foundation, in support of sending indigenous people to Uganda for a workshop on wildlife disease and management; to Alberta Birds of Prey Centre; to The Friends of the National Zoo in Accra-Ghana for the development of an operational plan; to Chobe Wildlife Trust, Botswana, to study effects of an artificial water supply on animal and plant populations; to the Belize Zoo and Tropical Education Centre to assist with rebuilding following damage by Hurricane Mitch; to Tree Kangaroo conservation in Papua New Guinea; to a sanctuary for Hippopotamus in Ghana; Sister Zoo assistance for Georgetown Zoo in Guyana, and Havana Zoo in Cuba; to the Conservation Breeding Specialist Group of the World Conservation Union, for conducting population and habitat assessments, and workshops for conservation assessment and management; Zookeepers organize “Bowling for Rhinos” to raise funds for Rhinoceros conservation.

Jungle Cat World: partnership with Endangered Species Fund of Canada, including distributing donation boxes at select businesses to fund captive-cat conservation projects in Canada and abroad; species awareness/fund-raising events with Land Rover dealers/owners for Amur Leopard field conservation and captive husbandry.

Toronto Zoo: awarded two Regional Conservation Awards (for Adopt-a Pond, and Massasauga Rattlesnake conservation) by the American Zoo and Aquarium Association; awarded grant for Puerto Rican Crested Toad conservation by AZA, Canadian Museum Association, and the Government of Canada; raised funds for a snakebite workshop for medical practitioners; in 1998, 28 projects were supported by the Toronto Zoo’s Endangered Species Reserve Fund.

Vancouver Aquarium: offers annual Murray A. Neuman Award, Finna Scholarship (Killer Whale research), and Lawson Scholarship (excellence in animal husbandry); BC Wild Killer Whale Adoption Program is a public-education program which also generates funds in support of conservation and research.

### **Publications, Technical Reports, and Conference Presentations**

By no means an exhaustive count, 104 publications involving aquarium/zoo staff were listed in the most recent annual reports between the years of 1996 and 1999. The main contributors were the Toronto Zoo (51), Vancouver Aquarium (30), and Biodome de Montreal (23). A remarkable number of science and conservation projects (often joint efforts with other agencies) were referred to in the lists of publications, but may or may not have been highlighted in the member submissions and annual reports. For a detailed listing of publications, interested persons should contact the major facilities. Several annual reports and submissions listed technical presentations and reports, often reflecting work noted in the above categories or in publications. Totalling 111, the main contributors were the Biodome de Montreal (79) and Toronto Zoo (28).

## **CONCLUSIONS**

In a descriptive survey such as this, there is space here for only a few general comments and conclusions. Primarily, it is gratifying to observe such a diversity of fields under investigation, many involving species at risk and others of an applied nature. Every class of vertebrate, and many types of invertebrates and plants received attention. Terrestrial, freshwater and marine ecosystems were all well represented, not only in Canada, but in many regions of the world. Certain studies involved zoological-support topics, such as habitat analyses, horticulture, and clean-up of wastes in natural areas. The number of entries in each survey category offer a good indication of the amount of research activity directed to each area. These can be summarised as follows:

Conservation Committees (12); Species Survival Programs (99), Studbooks (210), Special Interest Groups (numerous) and over 100 CITES-listed species; Canadian Collection Plan (4 zoos involved in preliminary work, using data provided by many other facilities); Habitat Research, Restoration and Preservation (36); Animal Population Surveys, Recovery Plans, and Release Projects (68); Behavioral Research (32); Husbandry Research (34); Veterinary Research (36); Physiological, Reproductive, Morphological, Biochemical, and Genetic Research (41); Nutritional Research (20); Horticultural Research (8); Registration and Data-management Research (9); Taxonomic and Anthropologic Research (7); Resource Conservation and Pollution Control (17); and Science and Conservation Awards and Fund-raising (55).

There were 104 publications and 111 projects and conference presentations listed, predominantly in several facility annual reports from 1996 to 1999. These numbers might actually be doubled if the data from all institutions over all four years had been provided. Also, the contents of these papers, project reports and conference talks were often not referred to specifically in the research categories of the facility submissions. Consequently, there was a body of science and conservation work during these four years that was not captured in this survey.

There was frequent mention of joint efforts with universities, provincial, state and federal wildlife agencies, and private conservation organizations, which demonstrates that zoo/aquarium staff are integrating, sharing and applying their skills and experience in ways that truly benefit natural science and wildlife conservation. Unexpectedly perhaps, but fully appropriate, was the frequent emphasis on Canadian species at risk. With COSEWIC's list of Canadian wildlife species and populations at risk surpassing the 300 mark this year, and biodiversity threatened in

many areas of the country, staff and resources at CAZA facilities are well placed to carry out technical investigations and procedures in both field and laboratory, as part of monitoring and rescue plans for Canadian wildlife. Conserving Canada's wildlife presents major challenges, and obstacles continue to mount.

This flurry of scientific investigation generates innovative ideas, attracts new partnerships and resources, generates funding support, and creates a momentum that makes aquariums and zoos exciting and productive places to work. Such positive incentives cannot help but attract highly qualified and energetic people to our field, which is so important to the future of zoos and aquariums in this country. With 'research and development' under budgetary attack in many sectors of society, it is essential that those operating zoos and aquariums (whether an individual, board, or city) be continually informed of the critical importance of supporting scientific and conservation work. The results of all these research activities and networking also emerge through imaginative educational programming -- exhibits, interpretive presentations, publications, media appearances, films, web sites, tours, etc. -- leading to greater public understanding and appreciation of Nature and to support for conservation initiatives.

Yet, the many and varied contributions of aquariums and zoos to science and conservation are not widely known by the public, nor even among aquarium/zoo staff in Canada. Likely all who review this report will be pleasantly surprised to see the extent of excellent work being pursued. This fact points out the need to publicize these achievements in a multitude of ways. With the pressures of daily work and responsibilities, it is all too easy to forget that other people -- in our and related fields, as well as the general public -- are keenly interested in what we are doing for the benefit of animal conservation and scientific knowledge. Perhaps we may be stimulated to disseminate information more widely than a technical report or speech to one audience. The results of this survey will, in some form, appear on CAZA's web site. To maintain current web-site information in the future, perhaps the CAZA Board might consider requesting that each facility submit their annual or other pertinent reports to the CAZA Office for entry. The new web site now appears to be the most economical avenue to present our messages, particularly to distance audiences and young people.

Zoos and aquariums in Canada maintain a veritable treasury of the world's life forms, including a high percentage of species at risk. This invaluable resource lies within easy access of most Canadians, students, and biological researchers. While there exists considerable use of these collections by staff and other researchers, the potential for more investigation is boundless and deserves encouragement. Through the involvement of researchers from other agencies, universities, and volunteers, the animal collections receive much-deserved scientific attention, ultimately benefiting the conservation of species in the wild.

Dr. William Conway, in his keynote address at the Seventh World Conference on Breeding Endangered Species (May 1999, Cincinnati), articulated the importance of linking "zoo and field," highlighting how wild- and zoo-animal interactive management and habitat protection are establishing zoos and aquariums as major proactive conservation organizations. The current review of recent activities of Canadian zoos and aquariums points out clearly that CAZA-member facilities are actively taking research and conservation beyond the perimeter fence, by

involving staff in cooperative wildlife research and management programs in their local communities, in many regions of Canada, and around the world.