WANTED: Species Survival Plan Coordinator

"Knowledgeable zoo or aquarium professional needed to manage the propagation of hundreds of animals located in several states and countries. Must be versed in genetics, sophisticated computer software, and exotic animal husbandry. Candidate will be responsible for keeping detailed animal records. Must like to travel and know how to deal with both domestic and foreign government agencies. Must perform job in addition to all regular duties. No salary. Apply to AZA Wildlife Conservation and Management Committee."

SSP Coordinator ad adapted from Wiese, R. J., and M. Hutchins. 1994. Species Survival Plans: Strategies for Wildlife Conservation. American Zoo and Aquarium Association. Alexandria, Virginia.

Does this ad sound like something of interest to you? It does to staff members of many zoos and aquariums across the country. In fact, there are Species Survival Plan (SSP) Coordinators for the Red-crowned Crane, Wattled Crane, White-naped Crane, Hooded Cranes, and Whooping Cranes.

What is a SSP?

- The SSP Program was created in 1981 by the American Zoo and Aquarium Association (AZA) to help ensure the survival of selected wildlife species, many of which are threatened by extinction.

- Each SSP manages the captive breeding of a species in North American zoos and aquariums .

- In addition to captive breeding, SSPs also coordinate public education, research, reintroduction, and field conservation efforts directed toward each species.

Why are SSPs important?

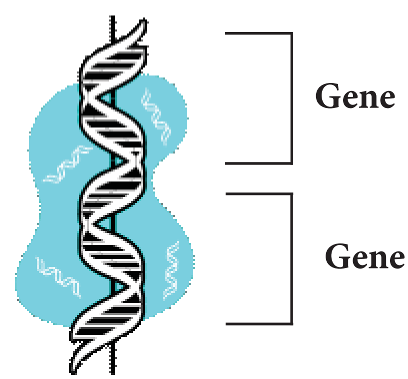
Captive breeding and reintroduction are sometimes the last remaining option for reestablishing a healthy wild population of a wildlife species. SSPs help coordinate breeding efforts so that captive populations remain healthy and become self-sustaining. One way that zoo and aquarium professionals maintain healthy captive populations is through the use of **studbooks**. These databases contain the records for an entire captive population of a species. A studbook is like a pedigree for a purebred dog, through which conservationists can determine the relationship between individuals within a population for breeding purposes. Many of our crane chicks are a product of a SSP Coordinator recommendation. For example, if the number of Whooping Cranes in captivity were not enough to support a genetically diverse population then a captive breeding protocal would be established.

Captive Breeding: Maintaining Healthy Populations

An important factor in a healthy wildlife population is **genetic diversity,** or variation in the genetic composition of individuals in a population. Species Survival Plans (SSPs) for endangered species, such as the Whooping Crane, attempt to retain as much of a population's genetic diversity as possible. Through the use of **studbooks** or pedigrees, SSPs identify breeding pairs to maximize genetic variation in a population and to minimize **inbreeding** or the mating of closely related individuals. Inbreeding may cause individuals to become more susceptible to disease and less reproductively healthy.

To understand how researchers maintain genetic diversity in a population, lets first examine a few of the basic components of life: **genes, DNA, and chromosomes.**

Our genetic composition is determined by specific chemicals within our cells. The nucleus of each cell contains many chromosomes, which are made of long strands of molecules called deoxyribonucleic acid, or **DNA**. Different segments of our DNA control different things in our body, whether it's eye color or red blood cell production. These segments of DNA are called **genes** (genetics is the study of genes). Genes are responsible for much of our physical appearance as well as the essential functions our body does in order to remain alive.



DNA

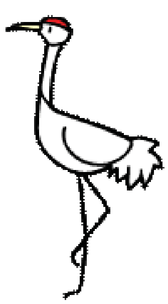
Each organism has a different number of chromosomes in their cells. For example, humans have 46 chromosomes which are divided into 23 pairs. In contrast, Whooping Cranes have 82 chromosomes, or 41 chromosome pairs in each cell. We inherit our genetic composition from our parents through the genetic information in our chromosomes (DNA and genes). In humans, each of our parents contributes one chromosome to every chromosome pair, so half of our genetic material comes from our mother and half from our father.

Where did you get all those alleles?

The genetic information for creating a living organism is passed from parents to their offspring through the genes found in our chromosomes. Among other characteristics, genes carry instructions for our physical appearance, or our **phenotype**.

In humans, we inherit genes from each of our parents that determine our eye color. A gene can be either **dominant** or **recessive**. These alternate forms of the gene are called **alleles**. Dominant alleles mask, or hide, recessive alleles, so the only way an individual can inherit a characteristic carried on a recessive allele, such as blue eye color, is by receiving two recessive alleles (one from each parent).

To examine how genes are passed to offspring from their parents, we can use a **punnett square**. The punnet square to the right examines the different gene combinations from a blue-eyed mother (dd) and a brown-eyed father (Dd).



Did you know that in Red-crowned Cranes eye color is also an inherited trait? Red-crowned Cranes may have black, brown, or green eyes. However, unlike human eye color, we do not fully understand how eye color is inherited in cranes.

D = ***Dominant allele (Brown pigment)***

d = ***Recessive allele (Blue pigment)***

Female Parent

Male Parent	d	d
D	Dd	Dd
d	dd	dd

Heterozygous = different alleles (Dd)

Homozygous = same alleles (dd)

Squared Away

Now it is your turn to do a punnett square.

Cross two crane parents that are both heterozygous. Remember a heterozygous parent has different alleles: one dominant and one recessive. Pick a letter to represent alleles: upper case meaning dominant allele and lower case meaning recessive allele. Write in the alleles for the parents underneath where it says 'Female Parent' and 'Male Parent'. In each blank only put one allele. Now start in the top left box and write in the corresponding allele from the female above the box and the corresponding allele from the male to the left of the box. Next go to the top right box and write in the corresponding allele from the female above the box and the allele from the male to the left of the box (the same allele you wrote in for the male in the top right box). Continue until all the boxes contain an allele from both the male and the female.

Female Parent

Male Parent

What are the odds of having an offspring with the dominant characteristic?

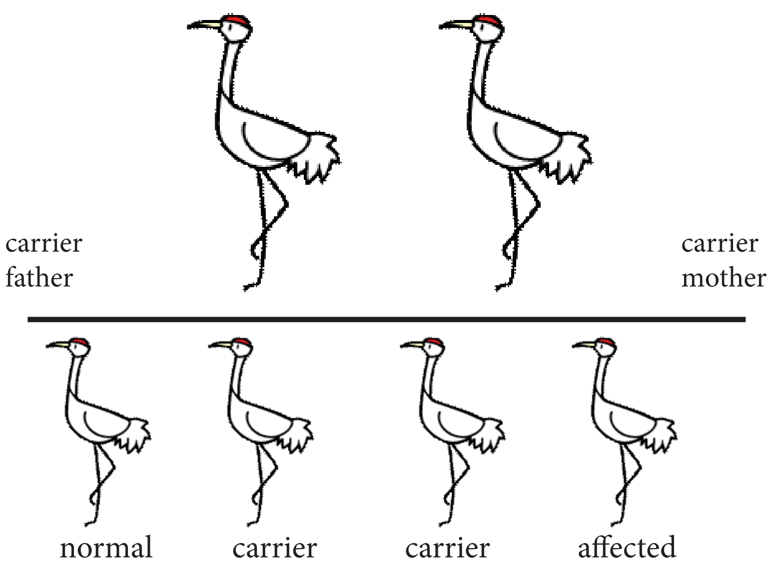
What are the odds of having an offspring with the recessive characteristic?

Too Close for Comfort:
The Dangers of Inbreeding

Many genetic disorders are carried on recessive alleles. Remember that in order to be affected by the disorder the organism must have two recessive alleles. In a healthy breeding population, the chances of inheriting a recessive allele for a genetic disorder is low due to high genetic diversity within the population.

However, inbreeding within a population can alter the genetic diversity. Inbreeding occurs when two closely related individuals breed and produce offspring. When this occurs, there is an increased chance that both parents will have a recessive allele for a genetic disorder that they can pass on to their offspring. An individual that is heterozygous for a particular gene is also called a **carrier**. Although the individual does not express the recessive allele himself, that individual still can pass that allele on to offspring.

Note: Not all genetic disorders are carried on a recessive allele. For our purposes, we are focusing on recessive alleles, because they play an important role in inbreeding.



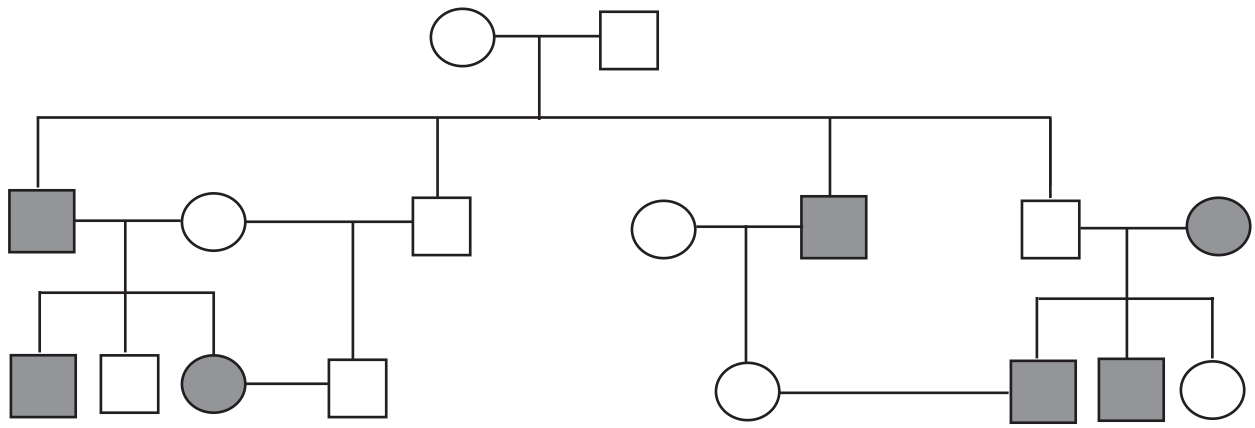
Female Parent

Male Parent	D	d
D	DD	Dd
d	Dd	dd

The above diagram shows how recessive genetic disorders are passed down from one generation to another. Think of it as a roll of the dice. When one of the parents is a carrier of a recessive genetic disorder, there is always a 1 in 4 chance of passing the disorder to their offspring. If the parents are closely related, there is an increased chance that both parents will carry the recessive disorder, which in turn increases the chance that their offspring will inherit the disorder.

How do you think this applies to endangered species?

Family Affair:
Using Pedigrees to Manage Captive Populations



A **pedigree** is a diagram of successive generations that may be used to trace a genetic trait over several generations. The above pedigree shows a total of three generations. In the pedigree, males are represented by squares and females are represented by circles. Individuals that have produced offspring together are connected by a line. An individual that is affected by a **recessive genetic disorder** is shaded.

Pedigrees are an essential tool in endangered species management. Many captive breeding facilities, like the International Crane Foundation, keep pedigrees or **studbooks**, on animals in their collections. The studbooks allow researchers to trace the relationships between individuals to reduce the chance that closely related pairs, which may carry a recessive genetic disorder, will breed and produce affected offspring.

Use the pedigree to answer the following questions:

1. Based on the pedigree, are the original male and female parents carriers of the recessive genetic disorder? Hint: To determine if the original pair are carriers, first look at the second generation. Are any of the individuals in the second generation affected by the genetic disorder? Remember that in order to be affected by a recessive genetic disorder, an individual must have two recessive alleles - one inherited from each parent.

2. Identify instances of inbreeding in the pedigree. If you were managing this captive population, what would you change to reduce the chances of inbreeding in the population?

INTERNATIONAL CRANE FOUNDATION

Genetic Diversity & Captive Populations

Whooping Crane Scoliosis

Scoliosis, or curvature of the spine, is a rare disease found in cranes. However, its increased incidence in the captive Whooping Crane population suggests that there may be an inherited susceptibility to scoliosis within this population.

In this activity, we will use a coin toss to determine how random changes in allele frequency may affect a wildlife population.

Directions:

1. Each person in the class represents a Whooping Crane in our captive population. To begin the activity, everyone in the class should flip a coin to determine their allele for scoliosis.

2. Record the alleles represented by the coin toss.

3. How many dominant alleles did the class get? How many recessive alleles did the class get? Record the results below:

Heads: R = less susceptible to scoliosis (dominant alleles)
Tails : r = more susceptible to scoliosis (recessive alleles)

Dominant Alleles ________ Recessive Alleles ____________

4. Read the scenarios on the next page. Have everyone in the class flip a coin to determine if they 'survive' the scenario.

5. Record the results of the alleles left surviving after the coin toss for each scenario. If you do not 'survive' a scenario you do not move on to the next scenario.

6. Remember to keep the original allele you received from the first coin toss.

Genetic Diversity & Captive Populations

1. After a new crane is added to the flock, your flock experiences an outbreak of the avian flu! Have every member of the flock flip a coin to see if they survive (Heads = Survive)

Using your original allele, how many of the surviving cranes have dominant alleles? How many have recessive alleles?

Dominant Alleles __________ Recessive Alleles _________

(Remember that if you didn't survive this scenario you do not go on to the next.)

2. A huge storm blows through your captive breeding facility! Have every member of the flock flip a coin to see if they survive (Heads = Survive)

Using your original allele, how many of the survivng cranes have dominant alleles? How many have recessive alleles?

Dominant Alleles __________ Recessive Alleles _________

3. A predator makes its way into your captive breeding facility! Have every member of the flock flip a coin to see if they survive (Heads = Survive)

Using your original allele, how many of the survivng cranes have dominant alleles? How many have recessive alleles?

Dominant Alleles __________ Recessive Alleles _________

Genetic Diversity & Captive Populations

Activity Summary: Genetic Diversity and Wildlife Populations

Did you loose an allele along the way? It is likely that after completing this activity, you experienced a decline in the frequency or number of one of the two traits (alleles) as your population declined. If your Whooping Crane population was reduced even further, you may lose either the dominant or recessive allele. This random change in allele frequency is called **genetic drift.** In this example, if the frequency for the recessive allele increased (more susceptible to scoliosis), the population could have an increased incidence of scoliosis, which might have a detrimental impact on the future health of the population. On the other hand, if the frequency for the dominant allele increased (less susceptible to scoliosis), the population could benefit.

Endangered species have a lot to worry about! More and more factors keep stacking up against them as their populations get smaller and smaller. Not only are many species losing their habitats, but they are also losing their genetic integrity as well. Inbreeding and loss of genetic diversity decrease a species' chances of survival. The more genetic diversity in a population, the more flexible and adaptable the species is to changes in its environment. However, once genetic diversity is reduced, it is extremely difficult to regain.

A **genetic bottleneck** describes the process by which a population undergoes a reduction in size and a resulting loss of genetic diversity. Often the population can recover its size but cannot recover its former genetic diversity.

The Whooping Crane

Population

- mid 1800s: 1,200 - 1,400
- 1941: 21
- 2006: approximately 485
- 2013: approximately 600

The Whooping Crane population passed through a severe genetic bottleneck after decimation of the species' population size in the late nineteenth and early twentieth centuries. As a result of this loss of genetic diversity, the current captive population may have an increased incidence of scoliosis, or curvature of the spine.

Range

The remaining migratory population breeds in northwestern Canada at the Wood Buffalo National Wildlife Refuge and winters at the Aransas National Wildlife Refuge on the Texas Gulf Coast. In 1993, reintroduction efforts were initiated to form a nonmigratory population in central Florida. In 2001, biologists initiated a second reintroduction project in central Wisconsin. This population will breed in Wisconsin and migrate to the Gulf Coast of Florida for the winter. Another flock was reintroduced to Louisiana in 2011.

The tallest North American bird, the Whooping Crane is also the rarest species of crane. Probably never an abundant bird, biologists estimate there were 500 to 1,400 Whooping Cranes alive in North America prior to1870. Hunting, egg collecting, disturbance and draining of wetlands took a heavy toll on the population, and by 1941 only twenty one birds remained. Six of these were in a nonmigratory flock in Louisiana and fifteen in a flock that migrated between northwestern Canada and the Texas Gulf Coast.

In 1954, the nesting grounds of the remaining wild flock were discovered. Ironically, the cranes were nesting in Canada's Wood Buffalo National Wildlife Refuge, an area already protected for the wood bison. Conservation of this area, along with the cranes' winter home at Aransas National Wildlife Refuge on the Texas Gulf Coast, have allowed this population to recover.

To ensure the survival of Whooping Cranes, biologists in the 1960s began securing a captive population. Because Whooping Cranes lay two eggs each year, but usually only one chick survives, biologists were able to take the extra eggs from wild nests that contained two eggs and raise those chicks in captivity.

However, of the fifteen Whooping Cranes that wintered at the Aransas National Wildlife Refuge in 1941, only three or four pairs had an opportunity to pass on their genes to future generations, forcing the population through a genetic bottleneck. Without enough genetic diversity, endangered species can succumb to the reduced vigor that results from inbreeding even years after the bottleneck occurs. When managing captive populations, curators must be very careful in their selection of pairs so that genetic diversity is preserved. A Whooping Crane population viability analysis (PVA) was conducted in the early 1990s, and although we know that significant genetic diversity was lost in the bottleneck, the PVA indicated that there was enough diversity that this species should be able to recover.