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Use of a Portable Tower and Remote-controlled Launcher to Improve Physical Conditioning in a Rehabilitating Wild Mallard (*Anas platyrhynchos*)

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Abstract: Prerelease reconditioning improves the chance of survival of rehabilitating raptors. Reconditioning may also help to rehabilitate waterfowl, including those that are threatened or endangered, especially if the birds are released during periods of migration. A flying harness, creance, remote-controlled launcher, and portable tower were used to create a means of reconditioning a rehabilitating 5-month-old female wild mallard duck (*Anas platyrhynchos*) that had been housed in a rehabilitation center for 7 weeks while recovering from an injury. Pre- and postflight serum lactate levels, body condition index scores, and controlled flight distances were used to assess the bird's degree of conditioning. Postflight serum lactate levels never returned to preflight levels and were not deemed a reliable indicator of physical fitness. However, the mallard showed an increase in endurance and strength as well as improved body condition index scores over the course of the reconditioning program.

Key words: wildlife rehabilitation, lactate, body condition index (BCI), reconditioning, avian, mallard, *Anas platyrhynchos*

Clinical Report

A 5-month-old female wild mallard duck (*Anas platyrhynchos*) was brought to the Wisconsin Humane Society's Wildlife Rehabilitation Center in June with a beak injury that resulted from a fish hook deeply embedded in the nares and rhinotheca. Over the following 7 weeks, the duck was confined to the facility while the injury was treated. The mallard was kept in an indoor stainless steel enclosure that was 70 cm deep, 114 cm wide, and 87 cm high. One side of the enclosure consisted of 2 side-by-side doors made of stainless steel rods spaced approximately 3 cm apart. When the beak injury was healed sufficiently to allow the bird to stretch and bathe, the mallard was given access to a room approximately 2.1 m wide, 4.6 m long, and 2.7 m high that contained an in-ground swim tub that was 61 cm wide, 150 cm long, and 40 cm deep. The bird was allowed two 20-minute stretching and bathing sessions each day but otherwise remained caged. Early in the bird's rehabilitation, the diet consisted of a mixture of cracked corn, poultry food, and duck starter mix (Purina Brand Duck Grower, Purina Mills LLC, St Louis, MO, USA) as well as greens added to the water. In an effort to increase the bird's weight once reconditioning began, the diet was changed to include a mix of commercial waterfowl food (Mazuri Waterfowl Breeder, PM Nutrition, International LLC, Brentwood, MO, USA) and meal worms in addition to the duck starter mix and greens. The meal worms and duck starter constituted approximately one-third of the total diet and were added to entice the mallard to eat the commercial waterfowl food.

Before the start of a reconditioning program to prepare the bird for release into the wild, a blood sample collected from the basilic vein was submitted for a complete blood cell count (CBC), and a fecal sample was submitted for centrifugation. The results of the CBC were within reference ranges,[1] and the feces contained no parasites or ova.

Because release back into the wild was being considered, concerns about deconditioning and its impact on survival prompted the attending clinicians to develop a device that made controlled reconditioning flights possible. The reconditioning construct used in this study consisted of

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a flying harness (Aviator Harness, The Parrot University, Sunbury, OH, USA); a creance composed of a fishing line, rod, and reel (Gander Mountain Competitor Youth Rod and Tournament Reel, Gander Mountain, St Paul, MN, USA); a 20-foot portable tower (designed by Holly Marie Pollard-Wright and David Kachelek, and manufactured by Model Manufacturing, Milwaukee, WI, USA); and a remote-controlled bird launcher (Dogtra RR Deluxe QL, Dogtra, Torrance, CA, USA). The flying harness chosen appeared least likely to interfere with normal wing movements and aerodynamics. The creance unit allowed the bird to be tethered while flying and easily retrieved after flight. The reel also included a "line counter," which recorded flight distances. The rod was shortened to improve handling and maneuverability. Creation of the 20-foot portable tower took into account both ease of set up and portability. The tower consisted of a center pole supported by a tripod base made up of 3 solid fiberglass rods and a center tripod support weldment. The 20-foot center pole was a 3-piece fiberglass unit (Fig 1). A movable shelf and pulley system fit over the center pole and was used to hoist the launcher to the top of the tower. Stabilizing lines attached to the top of the tower were secured to the ground. The tower could easily be set up and taken down by 2 people within 15 minutes and could be transported unassembled in a small sport utility vehicle. One advantage of having a portable tower was that it could be transported to different locations and used in a variety of terrains. The launcher system consisted of a metal launcher box with large holes in the sides that permitted maximum air flow, a mesh bird cradle that held the bird in position for launching, cradle arms attached to springs, a latch that held the bird cradle closed when set for launching, and a release lever. The system used a transmitter and receiver to communicate with a solenoid, which activated the launcher when the transmitter button was pressed. When the button was pressed, the latch was pulled, and pressure on the springs attached to the cradle arms was released. The height achieved by the launcher was determined by the amount of compression exerted on the cradle springs. The least amount of spring compression was chosen to minimize the stress on the bird and resulted in a 7-foot vertical launch.

The final form of the reconditioning device evolved from trial and error. During initial attempts at reconditioning, the mallard was flown with only the harness and creance. When the harness was used in a fashion similar to that used with parrots (ie, gently tossing the bird in the air to initiate flying), the mallard did not have sufficient time to overcome its body weight and quickly glided to the ground. Chasing the mallard to encourage flight also resulted in very short flights, with the bird preferring to run rather than fly. During additional trials, the bird was released from a plastic box, which had been raised to the top of the tower. However, the bird was unable to spread its wings as it was released from the box and instead glided to the ground without achieving substantial flight distances. At this point, the launcher was chosen to launch the bird from the ground. Because the device propelled the bird only 7 ft in the air, the mallard achieved heights similar to those resulting from being tossed in the air. Only when the bird was launched from the top of the tower was it able to spread its wings at the initiation of flight and

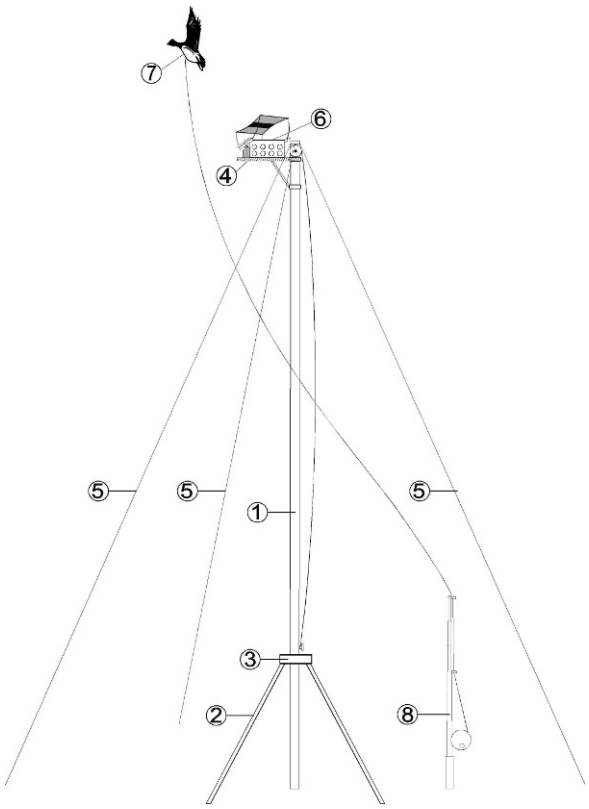

Figure 1. Schematic of a portable tower and remote-controlled launcher used in conditioning a rehabilitating wild mallard. Center pole (1), tripod base (2), center tripod support weldment (3), moveable shelf and pulley system (4), stabilizing lines (5), remote-controlled bird launcher (6), bird with flying harness (7), and creance (8).

Figure 2. The study mallard is launched from the portable tower and remote-controlled launcher for a conditioning flight.

achieve significant flight distances (Fig 2). The bird quickly habituated to the launcher with repeated flights.

The conditioning flight sessions were modeled on procedures used with raptors in both rehabilitation centers and research studies.[2,3] Guidelines for suitable ambient temperature, humidity, and wind speeds during flight sessions were taken from the creance technique used with raptors. Ambient temperatures during our study were 16.1°C–20.5°C (61°F–69°F), humidity was 66%–83%, and wind speeds averaged 2–8 mi/h. The bird was fasted for at least 12 hours before flying, which is a standard practice used in rehabilitating raptors before exercise but may not be necessary in ducks because of their shorter gastrointestinal tract transit time. Before each exercise session, the bird was weighed, and its feathers and feet were inspected. The bird was transported to the exercise sessions in a carrier while it was wearing the harness. Once at the flight location, the fishing line was attached to the harness with a secure clasp. The mallard had 3 flight sessions per week, on Sunday, Thursday, and Saturday. Each flight session consisted of multiple flights, each of which was followed by a period of rest during which the bird was brought back to the launcher. The first 2 flight sessions occurred in a small urban park near the rehabilitation center, and the remainder took place in a larger open area in a suburban park. This change was made because the bird tended to fly to shelter in the brush located around the initial park location. The period of rest between flights was initially 2–3 minutes but was increased to 3–5 minutes as the flight distances increased. The bird was gently restrained and brought back to the flight tower after each flight. A towel was initially placed over the bird's head while it was returned to the tower, but this was later stopped to ensure adequate ventilation.

Table 1. Serum lactate levels (mmol/L) measured during reconditioning of a rehabilitating 5-month-old female wild mallard. Blood was collected before flight conditioning and at the indicated intervals after flight.

Blood collection times	Serum lactate levels (mmol) per session						
	1	2	3	4	5	8	11
Preflight	3.9	5.1	3.4	3.1	3.3	3.8	4.8
2 min postflight[a]	High	High	High	High	High	21.2	High
10 min postflight[a]	20.1	19.7	10.2	15.3	High	8.2	11.3
15 min postflight							7.4
20 min postflight							8.2

[a] "High" denotes lactate levels that exceeded the portable monitor's lactate threshold (22 mmol/L).

During the first flight session, the launching platform was placed at its lowest height, which was approximately 5 ft up the tower. The bird made a total of 5 flights by using this launch height, with distances of 56–286 ft per flight. The bird appeared comfortable after flight during the first flight session, so the launching platform was raised to its maximum height of 20 ft. The goal distance for each flight was increased to 150–200 ft for the second flight session. When the bird reached the desired flight distance, gentle placement of a gloved thumb on the fishing line created drag that indicated to the bird a need to land. In each of the second through fifth flight sessions, the launching platform remained at 20 ft, and the bird made 5–7 flights of approximately 150–200 ft each. When the bird began to fly significantly shorter distances with each launch, or if the bird exhibited open-mouth breathing or drooped its wings, flights were discontinued for that session. Based on studies performed with raptors,[2] the maximum total flight distance for each session was limited to 1500 ft in the early sessions. After the sixth flight session, the bird showed no signs of fatigue after flying a total of 1500 ft, so the goal length for each subsequent individual flight was increased to 500 ft and the total goal flight distance for each session was increased to 4000 ft.

The mallard's physical fitness was evaluated based on endurance, serum lactate levels, and body condition index (BCI) measurements. The mallard's strength, endurance, and ability to pull against resistance during normal flight increased progressively throughout the study. In the final week of the study, the bird was able to fly a total of 3500 ft or more during each session without signs of overexertion or strain. Blood samples submitted for serum lactate levels were collected before flight sessions 1–5, 8, and 11, and at 2 and 10 minutes after each of these sessions was concluded. Blood was not drawn during flight sessions 6, 7, 9, and 10 to give the mallard a respite from phlebotomy. To minimize stress during blood collection, the bird was restrained on its side by using a towel, and its head was loosely covered. A drop of blood was collected from the medial metatarsal vein by using a 29-gauge needle attached to a 0.5-mL insulin syringe. The blood was applied to the yellow test pad on a lactate test strip (BM-Lactate Strip, Roche Diagnostics GmbH, D-68298, Mannheim, Germany). Lactate levels were determined by using a portable lactate monitor (Accutrend Lactate Monitor, Roche Diagnostics), which uses reflectance photometry at a wavelength of 657 nm in a colorimetric lactate-oxidase mediator reaction. The portable lactate monitor was used in this study, rather than sending blood samples to a commercial laboratory, for ease of sample testing and to minimize the risk of sample degradation. By using control solutions and the manufacturer's instructions, performance of the lactate monitor was evaluated throughout the study to ensure reliable lactate readings.

The bird's lactate levels 2 minutes after exercise remained above the monitor's recordable range (maximum recordable level = 22 mmol/L) throughout the majority of the study (Table 1). Only in flight session 8 was the postexercise lactate level in the recordable range. Lactate levels measured 10 minutes after exercise never returned to preflight levels throughout the study. The 10-minute postexercise lactate levels began to decrease between flight sessions 1 and 3 but then increased after flight sessions 4 and 5. Samples taken after flight session 8 showed lower lactate levels than previous samples, but samples taken after flight session 11 showed an increase in levels from flight session 8. Additional samples were taken during session 11, at 15 and 20 minutes after flight. The lactate level at 20 minutes after flight

Table 2. The morphometrics (wing chord length, head length, and body weight) used to calculate structural body size (the first principal component [PC1]) and body condition indices (BCI) as well as the PC1 and BCI values obtained for wild female mallards captured during April 2000 and the mallard in the current study (values bolded for the latter).

Weight (g)	Wing chord (mm)	Head (mm)	PC1	BCI
1010	**258**	**104.4**	**−0.56**	**28.0**[a]
920	**258**	**104.4**	**−0.56**	**−62.0**[a]
935	**258**	**104.4**	**−0.56**	**−47.0**[a]
980	290	108.5	2.66	−147.2
1040	265	105.4	0.16	25.1
900	264	102.8	−0.51	−84.5
940	258	106.1	−0.17	−59.8
1080	277	108.7	1.78	−7.7
980	255	99.7	−1.87	56.7
1000	269	105.9	0.56	−32.9
1060	270	102.1	−0.25	63.7
850	258	102.0	−1.12	−106.9
940	246	101.6	−2.06	25.6
1040	269	103.6	0.03	31.2
1070	267	105.8	0.40	44.6
940	248	100.0	−2.29	35.9
1130	263	110.4	1.18	69.2
1080	270	106.2	0.71	40.8
1140	271	109.7	1.59	61.0
1260	267	105.0	0.21	242.9
980	251	104.0	−1.15	24.5
960	257	104.0	−0.73	−14.7
860	256	105.1	−0.54	−123.0
880	265	104.5	−0.04	−125.5
1160	274	110.6	2.01	62.0

[a] Body condition was repeatedly evaluated for the study mallard, on September 3, 20, and 23, 2009 (935 g, 920 g, and 1010 g weight measurements, respectively), to determine its relative condition through the rehabilitation period. Wing chord and head length measurements from September 3, 2009, were used to calculate BCI for all weights. Structural body size was calculated as the PC1 of wing chord and head measurements. BCI is the regression residual of weight as a function of structural body size. Positive and negative BCI values represent females that are relatively heavy and light for their structural size, respectively.

was higher than that at 15 minutes after flight, and both were greater than the preflight level.

Measurements of head length (± 0.1 mm), wing chord length (± 1.0 mm), and weight (± 5.0 g) were recorded and used to calculate the BCI. Head length was recorded with calipers as the distance from the tip of the bill to the parietal bone above the occipital crest. Wing chord length was measured as the distance from the radial bone of the wrist to the tip of the most distal primary feather. The BCI score was calculated by conducting principal components analysis (PCA) on head and wing measurements from female mallards captured during April 2000 in north central Montana (n = 22) (J. M. W., unpublished data, 2000) and the female mallard in this study (Table 2).[4] The PCA combines a series of variables into a small number of linear ''components'' that explain the variation in the original set of variables.[5] For example, PCA can be used to combine multiple morphometrics into a single principal component that represents structural body size. The measurements taken from the female mallards in 2000 were required to conduct the PCA, which provided an index of female mallard structural body size. The study mallard's weight was regressed on the first principal component (PC1), with the residual from the regression representing a size-adjusted body condition index.[6] The PC1 explained 83% of the variation between head and wing length measurements. Based on BCI scores, the study mallard was in relatively poor body condition initially (ie, negative scores) but increased in body condition such that its mass was slightly above average for a mallard female of its structural size (Fig 3). At the end of the study, the bird was released in a rural, lowland, riparian habitat that contained areas of cattail marsh, tamarack swamp, small lakes, and a few scattered human residences.

Discussion

Wild mallards placed in rehabilitation facilities generally have difficulty habituating and experience a sharp decline in body weight, perhaps because of a lack of exercise or a general stress response. The lost body mass may only partially be regained (K. Reinecke, oral communication, 2009). Before releasing wild waterfowl, rehabilitators attempt to ensure that animals are physically and psychologically fit for release and are released at appropriate times and into appropriate habitats. Rehabilitators look for recovery from the primary injury or illness, reasonable physical conditioning and coordination, weatherproofing, an appropriate release site and seasonal timing of release, and behavioral and/or psychological fitness.[7] Restoring a bird to its previous level of conditioning and flight fitness is usually not considered feasible. Reasons for this include the fact that waterfowl are not food motivated and cannot be stimulated to make conditioning flights in flight cages. The body conformation of waterfowl also precludes making conditioning flights by using jesses, which are commonly used

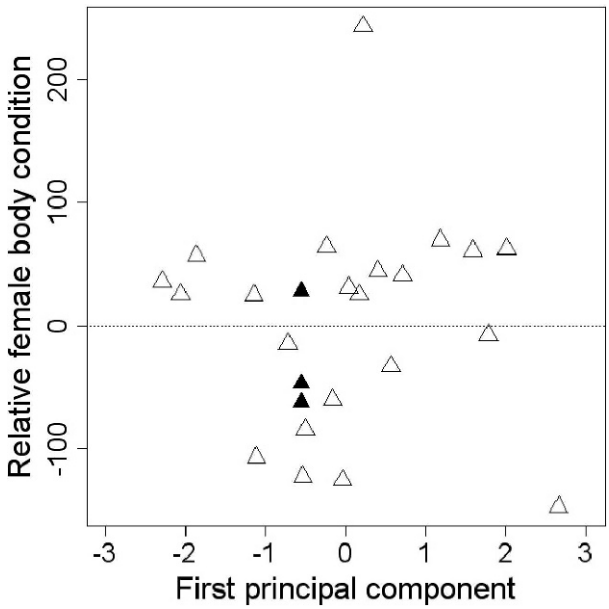

Figure 3. Relationship between female mallard structural size and relative female body condition. Structural size was quantified as the first principal component from a principal components analysis of wing chord and head measurements of wild female mallards (n = 22) and the female rehabilitated in this study. Negative values represent structurally small individuals; positive values represent structurally large individuals. Female body condition values are the residuals from the least-squares regression model of female weight as a function of structural size. Values above the dashed line represent females heavy for their structural size; values below the dashed line are females light for their structural size. Open triangles are wild mallard values. Closed triangles are the body condition values of the rehabilitated female from repeated weight measurements, with the triangle above the horizontal zero line indicating the final value calculated.

in creance flying in raptors.[8] When reconditioning is attempted, the most common technique rehabilitators use is releasing the bird in a protected area where it can achieve a level of physical conditioning on its own (a ''soft release''). However, the number of areas where waterfowl can be released safely to achieve physical conditioning is diminishing. Hypothesizing that a physically fit bird has a much better chance of survival after release than a deconditioned bird, and, by living in an urban area, we were inspired to develop a means of reconditioning waterfowl that was not dependent upon the large, protected, open areas used for soft release.

The optimum prerelease conditioning of a bird depends on many factors, including the availability of food and shelter in the area in which it will be released. The data on 1-way distances flown by waterfowl from roosting or sanctuary areas to feeding sites, often located in croplands, are quite variable (K. Reinecke, oral communication, 2009). Distances may be relatively short when food is abundant in the area, but, in a few case reports, average flight distances have been reported to be 10–16 mi. Because mallards have an average flight speed of about 50 mi/h, 12–20 minutes of sustained flight could be required to reach an adequate feeding area.[9–14] A bird that has been ill or injured and confined for a significant period of time may be unable to make such a flight without reconditioning.

The success or failure of a reconditioning regimen should be ascertained by using objective outcome measures. In this study, we assessed pre- and postexercise lactate levels and BCI scores. Serum lactate levels have been used as an indicator of fitness in several species, including humans, horses, and raptors.[15] A study performed at the University of Minnesota's Raptor Center (Minneapolis, MN, USA) showed that serum lactate levels in well-conditioned rehabilitating hawks peaked at 2 minutes after exercise and returned to preflight levels within 10 minutes after exercise, whereas nonconditioned hawks had higher peak lactate levels that did not return to preflight levels within 10 minutes. In that study, a red-tailed hawk (*Buteo jamaicensis*) that had been manned and was being used for hunting purposes was flown in the same way as the rehabilitated hawks, and blood samples were drawn at 2 and 10 minutes after exercise. Serum lactate values obtained from that bird were used as ideal indicators of physical fitness and standards in evaluating those obtained from rehabilitating hawks.[15] However, interpretation of serum lactate levels in birds can be difficult. In a study of serum biochemical analyses in mallards, age, sex, and reproductive conditions were found to significantly affect serum enzyme levels, including levels of lactate dehydrogenase (LDH), the enzyme that converts pyruvate, the final product of glycolysis, into lactate when oxygen is in short supply. The LDH levels were also elevated in hens during molt as well as in young birds, consistent with the association of this enzyme with integument and muscle. The study also stated that LDH values from wild-caught mallards may be difficult to interpret, because trapping and handling before obtaining samples may result in elevated values.[16] Given the results of these studies, it would be difficult to establish standard serum LDH and

lactate values for the purpose of assessing rehabilitating mallards, because birds treated in rehabilitation centers vary in terms of age, sex, and reproductive condition. Serum lactate levels for the mallard in this study remained high and never reached baseline levels throughout the study. The reasons for this are unclear. The study mallard was young and female, factors that could have played roles in the sustained higher lactate levels. Another possibility is that the bird's anaerobic threshold was exceeded in each flight session. Although wing loading is greater in mallards than in many raptors,[17] waterfowl are adapted to make regular flights over substantial distances. Considerable exercise may be required to regain the muscle strength that was lost while in captivity in a species that is accustomed to substantial daily flights (K. Reinecke, oral communication, 2009). Another possible explanation for the elevated lactate levels is that the study mallard never became accustomed to the blood sampling protocol, and stress from blood sampling could have caused the increase in blood lactate values. This possibility may be supported by the fact that, during the last flight session, the sample taken at 20 minutes after flight was higher than the sample taken at 15 minutes after flight.

The BCI is a common, nondestructive technique for quantifying relative body condition among individuals in studies of conspecific wild birds.[6] The BCI provides an assessment of body condition relative to body size but does not provide an absolute value that indicates readiness for release back into the wild. The value of using BCI scores in the rehabilitation of wild individuals for release is 1) the ability to correct mass relative to structural body size, and 2) the ability to compare the condition of the rehabilitated individual with wild conspecifics. A key assumption made in applying this method to rehabilitated individuals is that wild birds used to calculate the principal component that represented structural size are a random sample of the population. For example, if wild birds used to estimate BCI are small relative to the population, the BCI of the rehabilitated individual would be biased high. Wild females used to calculate the BCI for this study were of various age classes (ie, yearling and after-second-year females) and captured in decoy traps that have not been shown to have a capture bias. Both of these factors reduce the likelihood of our BCI being a biased metric mallard body condition.

The reconditioning methodology developed for this case may have applicability to other rehabilitating waterfowl. Future research using the device described here with a larger group of wild mallards might include a 3- to 4-week period of acclimatization to blood collection before beginning conditioning flights. In addition, using a larger population to study the relationship between body mass and body size during a period of reconditioning could help determine if these parameters represent valuable indicators of fitness in this species. Finally, a study that examines the survival of 2 groups of mallards, one conditioned before release with the modality used in this study and one released without conditioning, would be useful.

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