National Leadership Grants for Museums

Sample Application MG-30-15-0046-15
Project Category: Collections Stewardship

Brookfield Zoo
(Chicago Zoological Society)

Amount awarded by IMLS: $422,365

Attached are the following components excerpted from the original application.

- Abstract
- Narrative
- Schedule of Completion

Please note that the instructions for preparing narratives for FY2016 applications differ from those that guided the preparation of FY2014 and FY2015 applications. Most obviously, the names of the three narrative sections and the order in which they appear have changed. Be sure to use the narrative instructions in the FY2016 Notice of Funding Opportunity for the grant program and project category to which you are applying.

The international zoological community is in urgent need of a welfare monitoring tool designed to enhance the quality of life of individual animals. The Chicago Zoological Society (CZS) requests $422,365 to validate WelfareTrak®, a user-friendly web application that allows zookeepers to complete surveys for individual animals and generates reports that "flag" potential shifts in welfare status. Over a 22-month period, we will validate WelfareTrak® by assessing the system's ability to improve the welfare of individual chimpanzees. Chimpanzees serve as an ideal model for evaluating the tool, as the system is designed to highlight the unique needs and preferences of each individual in a population. The chimpanzee is a highly social, complex species prone to exhibiting abnormal behaviors (e.g. rocking, self-sucking), high rates of aggression and social deficiencies in captivity. While the Association of Zoos and Aquariums (AZA) and the Chimpanzee Species Survival Plan (SSP) promote the development of welfare assessment tools, no instruments currently exist for systematically monitoring chimpanzee welfare on a consistent basis.

CZS will partner with 15 AZA-accredited facilities and monitor 60 chimpanzees to: 1) to create a chimpanzee welfare survey with high levels of inter-rater reliability, 2) validate survey items using behavioral and/or physiological measures, 3) demonstrate that individual animal welfare improves following the introduction of WelfareTrak® and 4) evaluate whether zookeepers' behaviors, attitudes, beliefs and/or perceptions about welfare are positively impacted by the WelfareTrak® system. As a first step, we will recruit experts from the international zoo community to create a species-specific welfare survey for chimpanzees. The survey will be comprised of negative *and* positive welfare indicators that reflect an animal's physical, mental and emotional states (e.g. coat condition, attitude). Then, for a 9-month period (a 3-month *Baseline Period* followed by a 6-month *WelfareTrak Period*), partner facilities will collect behavioral and physiological data on each study animal. Data collection will include: 1) videotaping each study animal 3 days per week for a 30-min period, 2) documenting all wounding events ad libitum, and 3) collecting daily fecal samples to determine baseline fecal glucocorticoid metabolite concentrations (an indicator of potential stress responses) and secretory immunoglobulin-A concentrations (an indicator of immune function). Following the 3-month Baseline Period, staff members at each facility will utilize the WelfareTrak® application for the 6-month WelfareTrak Period. Zookeepers will complete welfare surveys for individual animals on a weekly basis and document events believed to impact welfare scores. As part of the monitoring process, workgroup members at each facility will review each subject's welfare report during monthly meetings to: 1) identify potential welfare issues, 2) attempt to address these issues by proposing feasible changes to the environment and/or husbandry routine, and 3) evaluate the success of these interventions. Data collected during the implementation of WelfareTrak® will be compared to baseline information to determine the impact on chimpanzee welfare. The entire 9-month dataset will be used to examine the inter-rater reliability and validity of particular welfare survey items. Finally, all staff members will complete a questionnaire about approaches to welfare monitoring both before and after data collection to determine whether exposure to the WelfareTrak® system positively influences behaviors, attitudes, beliefs and/or perceptions about chimpanzee welfare.

The proposed project will benefit *all* animal care facilities in search of a user-friendly welfare monitoring tool for individual animals. After providing evidence that WelfareTrak® can enhance the quality of life of individual animals, we foresee wide-scale adoption of the system for not only chimpanzees – but for a variety of mammal, bird and reptile species. We anticipate great interest in previously developed welfare surveys, as well as requests to generate new species-specific surveys. Ultimately, validating WelfareTrak® has the ability to revolutionize how zoos and aquariums monitor each individual to ensure that it is thriving. WelfareTrak® will give animal care facilities the opportunity to intervene rapidly when welfare issues arise, resulting in improved health, longevity and quality of life for all captive animals.

Project oversight will be directed by Jessica Whitham, Ph.D., Animal Welfare Biologist and Lance Miller, Ph.D., Senior Director of Animal Welfare Research. CZS will work closely with the SSP's Chair and Research Advisor to carry out all project activities. IMLS funds will be used to: 1) provide the equipment and supplies needed to collect the behavioral and physiological data at each facility, 2) process and assay all physiological samples, and 3) support the post-doctoral scientist, endocrine laboratory manager and research assistant responsible for data analysis. Additional funds will be utilized to disseminate results to our target audience.

NARRATIVE

PROJECT JUSTIFICATION

In recent years, the zoological community has dramatically increased efforts to systematically assess and improve animal welfare (Barber, 2009; Hosey et al., 2009; Barber et al., 2010; Butterworth et al., 2011). The Association of Zoos and Aquariums (AZA) traditionally has promoted a resource-based approach to welfare assessment by focusing on the parameters deemed necessary to provide the *potential* for good welfare in a species (e.g. space, shelter, management practices). However, this indirect approach does not ensure that each individual animal will thrive in its environment (Barber et al., 2010; Butterworth et al., 2011). To enhance the quality of life of each individual in a population, many welfare scientists endorse the use of holistic instruments that capture the assessments of those most familiar with the animal: the caretakers (McMillan, 2000; Meagher, 2009; Whitham & Wielebnowski, 2009, 2013). Many zookeepers spend decades working not only with particular species but also with particular individuals. Indeed, there is strong evidence that zookeepers can reach high levels of inter-rater reliability when assessing traits that reflect welfare status and that such assessments can be validated by behavioral and/or physiological measures (reviewed in Gosling, 2001; Meagher, 2009; Whitham and Wielebnowski, 2009).

In 2013, the Chicago Zoological Society's Center for the Science of Animal Welfare (CSAW) launched a web application, WelfareTrak®, which gives zookeepers the opportunity to complete online surveys to monitor the welfare of individual animals on a weekly basis. Each species-specific survey is comprised of negative *and* positive welfare indicators that reflect an animal's physical, mental and emotional states (e.g. coat condition, attitude, calm behavior). The WelfareTrak® system also generates reports that graph the zookeepers' scores and "flag" potential shifts in welfare status. With the support of an IMLS National Leadership Grant, we collaborated with five organizations accredited by the Association of Zoos and Aquariums (AZA) to test our online system, refine our resources and identify models for integrating WelfareTrak® into daily operations. Following a 1-year period of tool testing, we interviewed each of the 48 animal care professionals (e.g. zookeepers, curators, researchers, veterinarians) who participated in the study. Overall, the participants felt that WelfareTrak® helped to: 1) promote discussion, 2) proactively identify welfare issues, 3) evaluate the success of efforts to improve individual animal welfare, and 4) gain insight into whether individuals prefer particular conditions, events or practices. While we did not collect the animal data required to demonstrate that WelfareTrak's implementation resulted in shifts in welfare status, CZS received positive feedback – including compelling anecdotal evidence of the tool's ability to improve the lives of individual animals. As a keeper of 14 years simply stated, "WelfareTrak® made me more observant of their 'whole selves'… it made me look at every aspect of the animal." The goal of the current study is to collect behavioral and physiological data to validate WelfareTrak® as a monitoring tool and to assess the system's ability to enhance the welfare of individual chimpanzees.

There are approximately 2,000 chimpanzees living in the United States, with 259 of those being cared for in 34 facilities accredited by AZA. The Chimpanzee Species Survival Plan (SSP) guides the management of the population and even promotes the well-being of chimpanzees living outside of these facilities. While the current mission of AZA's Animal Welfare Committee (AZA, 2014) includes, "encouraging the development of research projects and assessment tools to advance and monitor animal welfare," no instruments exist for systematically tracking chimpanzee welfare on a regular basis.

WelfareTrak® is ideal for monitoring chimpanzees, because the system is designed to highlight the needs, preferences and perspectives of each individual in a population. The chimpanzee is a highly social, complex species that lives in relatively large troops. Captive chimpanzees are at risk of developing various abnormal behaviors (e.g. coprophagy, self-sucking), displaying high rates of aggression and failing to demonstrate

appropriate social, breeding and/or maternal behaviors (e.g. Nash et al., 1999; Bloomsmith & Else, 2005). Individuals with atypical early life experiences are especially prone to developing aberrant behaviors (e.g. rocking) and exhibiting social deficiencies (e.g. lower frequencies of grooming and sexual behavior) (e.g. Bloomsmith et al., 1991; Freeman & Ross, 2014). In a recent survey conducted by the SSP, each of the 24 facilities that participated in the study reported housing at least one chimp that displayed abnormal behaviors (Ross & Bloomsmith, unpublished data). Therefore, there is great need for an instrument that helps zookeepers focus on individuals with unique rearing histories, personalities and requirements. Fortunately, there is strong evidence that zoo employees are able to reach high levels of agreement when rating subjective well-being or "happiness" in chimpanzees and that assessments can be validated by behavioral measures (King & Landau, 2003). The Chimpanzee SSP strongly endorses the proposed study, with both the Chair (Dr. Steve Ross) and Research Advisor (Dr. Mollie Bloomsmith) serving as advisors on the project *(see attached: Endorsement Letter from the Chimpanzee SSP)*. The SSP also recognizes the potential for WelfareTrak® to enhance the welfare of chimpanzees living outside of AZA-accredited facilities. Ultimately, the tool can aid chimpanzees found in all types of captive settings, including those housed in sanctuaries, laboratories and conservation centers.

In addition to generalizing our results to captive chimpanzees, this project will allow us to enhance the quality of life for individuals representing a variety of other species. After demonstrating the validity of the WelfareTrak® system (by providing evidence that individual animal welfare improves following the introduction of the tool), we will focus on growing our Survey Library by developing species-specific welfare surveys for additional species. There are thousands of species – and countless numbers of individuals – that could benefit from a tool like WelfareTrak®. This instrument will allow AZA-accredited facilities to not only satisfy the biological needs of a species – as outlined in husbandry templates and care guidelines – but to perform "whole animal" assessments that capture subtle changes in an individual's welfare status (e.g. a hunched posture, dull eyes). Furthermore, unlike typical approaches to welfare assessment that simply aim to avoid poor welfare, WelfareTrak® considers measures of positive welfare (e.g. a gorilla's "content" grumbles) and highlights improvements in welfare status.

Over the course of nearly two years, we aim to partner with 15 AZA-accredited facilities to create a welfare survey for chimpanzees and to demonstrate that WelfareTrak® is a user-friendly tool that will help caretakers measure and possibly improve the physical, mental and emotional states of individual animals. Ultimately, we anticipate that WelfareTrak® will foster an industry-wide shift in AZA's approach to welfare assessment – placing the focus on individuals and encouraging caretakers to continuously strive to enhance each animal's quality of life.

PROJECT WORK PLAN
Over a 22-month period, we plan to partner with 15 facilities *(see attached: List of Partner Facilities; Statements of Support)* and monitor 60 chimpanzees to address the following research questions:

1) Can we create a chimpanzee welfare survey with high levels of inter-rater reliability?

2) Can we validate individual items on the chimpanzee welfare survey using behavioral and/or physiological measures of welfare?

3) Using the chimpanzee as a model species, can we demonstrate that the welfare of individual animals improves following the introduction of the WelfareTrak® system?

4) Do zookeepers' behaviors, attitudes, beliefs and/or perceptions about the welfare of individual chimpanzees change after experiencing the WelfareTrak® system?

Activity 1: Consult with experts to develop a welfare survey for chimpanzees
December 2015 – February 2016
Over a 3-month period, Dr. Jessica Whitham will coordinate the development of a species-specific WelfareTrak® survey for chimpanzees. WelfareTrak® surveys are created using the Delphi technique, a process that involves consulting with expert panelists to achieve a consensus of opinion regarding subjective judgments (Linstone & Turoff, 1975). The Delphi technique has been used by farm animal welfare researchers to identify appropriate animal-based measures (e.g. mental state, attitude) for dairy cattle, pigs and hens (Whay et al., 2003). CZS has employed this technique to develop surveys for nearly 20 species of mammals, birds and reptiles.

CZS will work with the Chimpanzee SSP to recruit 8-10 experts (e.g. keepers, curators, behavioral researchers, veterinarians) from the international zoo community for the tool development process. Each consultant will complete an electronic version of the WelfareTrak Tool Development Questionnaire *(see attached: WelfareTrak Tool Development Questionnaire)*. Experts will be required to: 1) answer open-ended questions regarding welfare (e.g. how do you determine whether an individual is comfortable?), 2) list and define the most appropriate indicators of both poor welfare and good/great welfare and 3) rate various terms on their usefulness for monitoring individual animal welfare. Experts will need only 45-60 minutes to complete the questionnaire but will have 3-4 weeks to submit their responses.

Dr. Whitham will compile all feedback to create a draft survey that lists the proposed welfare indicators and accompanying definitions. The experts then will be given the opportunity to revise the draft survey. Additional drafts will be created, if necessary. The final version, which will be comprised of 10-15 items (e.g. attitude, physical condition) rated on a 5-pt Likert scale, will be uploaded to the WelfareTrak® web application.

During this period, CZS also will prepare partner facilities for data collection. We will randomly choose study animals for each facility that is unable to monitor all individuals in its collection (only adult individuals free of progressive diseases will be included). In the interest of being able to generalize our results to the entire population of zoo-housed chimpanzees, we will not specifically recruit individuals with known welfare issues. We also will create a video to demonstrate proper data collection techniques – including tips for videotaping behavioral observations and instructions for gathering fecal samples. In addition, we will incorporate a WelfareTrak® training presentation that will guide participants through online survey completion and provide suggestions for reviewing welfare reports. We will coordinate with each facility to ensure that each staff member is fully trained before data collection begins.

Finally, each staff member involved in the project will complete a brief (2-pg) online questionnaire about his/her facility's approach to welfare monitoring *(see attached: Approaches to Welfare Monitoring Questionnaire)*.

Activity 2: Collect behavioral and physiological data on study animals
March 2016 – November 2016
For a 9-month period (a 3-month *Baseline Period* followed by a 6-month *WelfareTrak Period*), partner facilities will collect behavioral and physiological data on each study animal. A staff member or volunteer from each facility will videotape each individual 3 days per week for a 30-min period at pre-determined times. We will work with each facility to determine a schedule that will not interfere with animal management needs. Video

will be scored by CZS staff (see Activity 4). Each facility also will document all wounding events ad libitum. To record these events, zookeepers will use a form developed by Ross and colleagues (2009) in a previous study of chimpanzee wounding rates *(see attached: Chimpanzee Wounding Data Form)*.

To non-invasively monitor physiological indicators of welfare, keepers will collect daily fecal samples each morning. Fecal samples will be stored at -20°C immediately after collection. Following each 3-month period of fecal collection, the facilities will ship the samples on dry ice to CZS' Endocrine Lab for analysis (see Activity 4). Samples will be analyzed to determine fecal glucocorticoid metabolite (FGM) concentrations which reflect activation of the hypothalamic-pituitary-adrenal axis and may indicate a detrimental stress response (Moberg & Mench, 2000). There is evidence that high concentrations of FGMs are associated with abnormal and self-injurious behaviors in zoo animals (e.g. Carlstead et al., 1993; Wielebnowski et al., 2002). Fecal samples also will be used to determine secretory immunoglobulin-A (IgA) concentrations, an indicator of immune function that has been shown to increase after experiencing positive emotional states in humans (reviewed by Pressman & Cohen, 2005). In dogs, salivary IgA was found to be negatively correlated with salivary cortisol and also associated with behavioral assessments. For example, low levels of IgA were found for dogs "exhibiting stress" while high levels of IgA were found for dogs considered to be "calm" and "confident" (Skandakumar et al., 1995).

Activity 3: Utilize the WelfareTrak® application to monitor individual animal welfare
June 2016 – November 2016
While continuing to collect all behavioral and physiological data as outlined above (see Activity 2), animal care staff also will utilize the WelfareTrak® application to monitor individual animal welfare. Each facility will identify: a) a Coordinator (e.g. curator, manager), b) 2-3 primary caretakers to serve as Raters, and c) a workgroup comprised of the Coordinator, Raters, other keepers and relevant staff members (e.g. veterinarians, researchers).

Each Rater will login to WelfareTrak® on a weekly basis to complete surveys for individual animals. The online survey completion process involves two steps: 1) entering basic information about the individual animal being rated (e.g. how many hours the Rater spent working with the animal during the survey week), and 2) completing the welfare survey by rating the animal on 10-15 welfare indicators. Each survey can be completed in only 2-3 minutes. In addition, Raters can login to the "Special Events" section of the website on an ongoing basis to document events believed to impact scores (e.g. change in housing, severe weather). This section even allows Raters to document intentional changes made to the husbandry routine or environment – and to visually highlight these interventions. It is also possible to review and edit the events entered by other Raters *(see attached: Screenshots of the WelfareTrak® System)*.

The Coordinator will organize monthly workgroup meetings to review welfare reports for each study animal. Reports will be projected onto a screen using an LCD projector OR viewed using tablets/iPads. The WelfareTrak® system generates two types of reports. Trend Reports include separate graphs for each welfare indicator and show patterns of scoring over time (either for individual raters or the mean for the group). Individual Well-Being Reports include separate tables for each welfare indicator and "flag" shifts in scores using symbols and banners. Specifically, green symbols and banners appear when scores improve, while red symbols and banners appear when scores deteriorate. Users also can generate a Summary Report that lists the basic information provided by the Raters, a summary table of all flags (i.e. potential shifts in welfare status) and the Special Events documented by the Raters *(see attached: Screenshots of the WelfareTrak® System)*.

During monthly meetings, the workgroup should review reports to identify potential welfare issues, to attempt to address these issues and to evaluate the success of these interventions. If a study animal receives a "flag" for a particular welfare indicator, the workgroup will discuss specific factors that may have caused scores to deteriorate or improve. For an apparent case of deteriorating welfare (red flag), the workgroup should attempt to address the issue by proposing a feasible change to the environment and/or husbandry routine. The workgroup then can evaluate the success of this intervention by considering whether welfare scores show improvement in subsequent reports. For example, during beta testing, an okapi workgroup noted that "red flags" appeared for a male who began to repetitively chew on non-food items. The workgroup scheduled a brainstorming session to identify new activities, enrichment items and substrates to stimulate the subject. The workgroup continued reviewing reports in subsequent meetings and reported a dramatic reduction in chewing. Alternatively, for a case in which welfare scores improve unexpectedly (green flag), the workgroup can gain insight into whether particular conditions, events or practices were beneficial to the individual. Finally, for cases in which an individual regularly receives "fair" or "good" scores, the workgroup should strive to attain "excellent" scores by introducing changes to the environment and/or husbandry routine.

At the end of this 6-month period, all staff members involved in the project will complete another brief (2-pg) survey about approaches to welfare monitoring.

Activity 4: Code video and analyze physiological data
December 2016 – March 2017
Over a 4-month period, CZS staff will: a) view all videos to code the behavioral data, and b) analyze the fecal samples to determine fecal glucocorticoid (FGM) and immunoglobulin-A (IgA) concentrations.

a) Videos of all behavioral observations will be scored by CZS' Animal Welfare Research Team using a modified version of the ethogram developed by Ross & Lukas in 2001 *(see attached: Chimpanzee Ethogram)*. We will use instantaneous sampling to record the behavioral state (i.e. behaviors lasting for relatively long periods of time; e.g. pacing, playing) of the subject at 1-min intervals during each 30-min session. This sampling technique will allow for an estimation of the proportion of time spent in each behavioral state. In addition, all-occurrence sampling of some behavioral events (i.e. behaviors that are relatively short in duration; e.g. contact aggression, coprophagy) will be conducted. These data will allow us to assess the frequency of aberrant behaviors such as repetitive movements and potentially self-destructive behaviors.

b) All FGM and IgA analyses will be conducted at CZS' Endocrine Lab. To determine FGM concentrations, we will use previously established and validated fecal hormone metabolite extraction and enzyme immunoassay (EIA) techniques (Möstl & Palme, 2002). Briefly, aliquots of 0.5g of wet feces will be extracted in 80% ethanol and distilled water by shaking overnight. After centrifuging for 15 min, 1 ml of supernatant will be added to 1 ml of assay buffer. Extracts will be stored at -20°C until assaying. FGMs will be measured using a corticosterone kit from Enzo Life Sciences, Inc. following the manufacturer's instructions.

For IgA extraction and analysis, we will follow techniques previously developed and validated for a number of species, including dogs, rats, pigs and primates (Eriksson et al., 2004; Peters et al., 2004; Royo et al., 2005; Paramastri et al., 2007). Extraction procedures will include dilution of the homogenate with PBS, as described by Hau and colleagues (2001). Extracts will be stored at -20°C until assaying. IgA will be measured using a coating antibody of goat anti-human IgA (Fc, 7S) and a secondary antibody of goat anti-human IgA (Fc) PO (Sapphire North America).

Activity 5: Data analysis

April 2017 – June 2017
We expect to demonstrate that the chimpanzee survey is comprised of reliable items (i.e. welfare indicators such as appetite, physical condition, aberrant behaviors) with high construct validity and that the process of completing WelfareTrak® surveys/reviewing reports improves the welfare status of individual animals. We also anticipate that exposure to the WelfareTrak® system will positively influence keepers' behaviors, attitudes, beliefs and/or perceptions about chimpanzee welfare.

Before addressing our research questions, we will analyze the entire dataset to determine how *daily* fecal samples collected to measure FGM and IgA concentrations correspond to the behavioral data (collected three days per week).

To determine if the chimpanzee welfare survey has high levels of inter-rater reliability (**Research Question 1**), we will analyze the entire 9-month dataset to compute intra-class correlation coefficients (ICC) for each survey item (Shrout & Fleiss, 1979). Items showing low levels of inter-rater reliability (i.e. those for which the ICC fails to reach statistical significance) will not be included in the validation analyses below. We also will investigate whether reliability levels are influenced by factors such as facility, week of the study, etc.

We also will analyze the complete 9-month dataset to evaluate whether individual items on the chimpanzee welfare survey can be validated by behavioral and/or physiological measures of welfare (**Research Question 2**). Specifically, we will run a repeated measures General Linear Model (GLM) to search for relationships between welfare scores and the behavioral, physiological and wounding data. We will evaluate whether ratings for a particular item are correlated with FGM concentrations, IgA concentrations, the proportion of time spent in relevant behavioral states (e.g. pacing), the frequency of relevant behavioral events (e.g. contact aggression) and the number of wounds received. The repeated measures GLM also will allow us to investigate whether individual animal welfare improves following the introduction of the WelfareTrak® system (**Research Question 3**). To examine the impact on overall welfare status, comparisions will be made between the Baseline Period (months 1-3) and the WelfareTrak Period (months 4-9). We should note that we have chosen to *not* return to the original condition (i.e. behavioral and physiological monitoring without implementation of WelfareTrak®) for ethical reasons, as we strongly believe that the tool will positively impact the study animals.

We will analyze the Approaches to Welfare Monitoring Questionnaires completed by all staff members from our partner facilities (**Research Question 4**). We will compare changes in identical questionnaire items from the Baseline Period to the WelfareTrak Period. We will look at the frequency of respondents that experience a positive, negative or no change in behaviors/skills, attitudes, beliefs and perceptions about welfare. We also will conduct a thematic analysis of the open-ended questions. Finally, it will be possible to determine whether *perceived* positive changes are associated with actual improvements in individual animal welfare.

Activity 6: Dissemination of results
July 2017 – September 2017
To reach a broad audience, the results of this project will be published in peer-reviewed journals such as Animal Welfare, Applied Animal Behaviour Science, Zoo Biology and veterinary journals such as JAVMA. We also will publish reports in industry-wide magazines such as AZA's CONNECT magazine, the European Association of Zoos and Aquaria's Zooquaria magazine and the World Association of Zoos and Aquarium's WAZA magazine. Presentations will be delivered at national and international conferences, including AZA and the American Society of Primatologists.

In addition, we will share our findings on WelfareTrak's informational site (https://www.welfaretrak.org). This website is accessible to our intended audience – the zoological community – as well as other types of facilities that have expressed interest in WelfareTrak®: animal shelters, laboratories, wildlife sanctuaries and rehabilitation centers. We will work with CZS' Marketing Department to generate press releases for CZS' website, CZS' Gateways magazine and local newspapers.

Finally, we will submit individual reports to each partner facility, as well as summary reports to the SSP and other appropriate AZA committees. We will work with the AZA Animal Welfare Committee to encourage members to apply this tool at their facilities.

Personnel

Dr. Jessica Whitham, Animal Welfare Biologist for CZS, received her graduate training from the University of Chicago's Department of Comparative Human Development. She is a leader in efforts to monitor the welfare of individual animals in zoo collections. Her interests include integrating measures of positive welfare into monitoring schemes, identifying new tools for welfare assessment and providing training to transform animal caretakers into welfare practitioners. Dr. Whitham has spent nearly 15 years designing, implementing and analyzing behavioral studies for a variety of taxa. She also has experience monitoring the physiological stress responses of birds, mammals and reptiles using enzyme immunoassay analyses. She is co-developer of the WelfareTrak® application and coordinated a large-scale study to test the system's beta resources. Dr. Whitham's undergraduate and graduate research focused on primate communication and cognition and included studies on Great Apes. Dr. Whitham will devote 30% of her time in Year 1 and 10% of her time in Year 2 to coordinating project activities, including: communicating with partner facilities, advising CZS staff responsible for coding videos and assaying samples, analyzing the complete dataset and disseminating results.

Dr. Lance J. Miller received his graduate training in Experimental Psychology from the University of Southern Mississippi. Throughout his career he has worked as a Research Manager at Disney's Animal Kingdom, Scientist for the San Diego Zoo Institute for Conservation Research, and is currently the Senior Director of Animal Welfare Research for the Chicago Zoological Society – Brookfield Zoo. Dr. Miller focuses on animal welfare to help ensure that each individual animal within zoological facilities is thriving. He is currently a member of the Association of Zoos and Aquariums (AZA) Research and Technology Committee, Vice Chair of the AZA Animal Welfare Committee, and a steering committee member for the AZA Behavioral Scientific Advisory Group. Dr. Miller will allocate 2.5% of his time in both years to overseeing the project and contributing to the dissemination of results.

Dr. Steve Ross is the Director of the Lester E. Fisher Center for the Study and Conservation of Apes at Lincoln Park Zoo (Chicago, IL), the Coordinator of the Chimpanzee Species Survival Plan (SSP) and Chair of the Board of Directors at Chimp Haven (Keithville, Louisiana). His research has primarily focused on the assessment, measurement and ultimately the improvement of well-being for captive apes in a wide range of settings. With 20 years of experience studying the behavior of a variety of primate species, Ross has focused his research on areas in which the science can have applied value on management and can affect policy. Dr. Ross will serve as an advisor on the project and will help disseminate the results, including introducing WelfareTrak® to members of the Chimpanzee SSP and sanctuaries that collaborate with AZA.

Dr. Mollie Bloomsmith is the Head of the Behavioral Management Unit at the Yerkes National Primate Research Center where she supervises the enrichment, socialization and animal training programs for primates and publishes research to improve the care and welfare of captive primates. She conducts research to evaluate behavioral management in laboratories and in zoos, and has published more than 100 articles related to this

topic, with more than 40 focusing on chimpanzee welfare. Dr. Bloomsmith teaches workshops on primate welfare, is the Chair of the Primate Care Committee of the American Society of Primatologists, is a founding board member of Chimp Haven (a chimpanzee sanctuary), has served for many years on the editorial board of two welfare journals, and is the Research Advisor to the Chimpanzee Species Survival Plan. Dr. Bloomsmith will serve as an advisor on the project and will help disseminate the results, including promoting WelfareTrak's use in sanctuaries and laboratories.

Jocelyn Bryant, Endocrinology Lab Manager for CZS, received her B.S. in Wildlife Ecology from the University of Wisconsin-Madison (1999), and completed her M.S. in Biology from the University of Nebraska (2010). She worked as a lab manager at the University of Chicago for one year where she set up an Enzyme-Immuno Assay Lab for the Biopsychological Sciences Building. In 2006, Jocelyn became the lab manager at Brookfield Zoo. She currently has over 50 species validated for reproductive and stress hormone assays and successfully runs one of the only three service labs in the country. Data provided by the lab has been used to improve reproductive success, pregnancy diagnosis, and shown effects of transport and other events on species' physiological stress response. Jocelyn also continues her position as the Communications Chair for the International Society of Wildlife Endocrinology (ISWE), networking and collaborating with fellow wildlife endocrinologists world-wide and staying on the forefront of new techniques. Ms. Bryant will spend 10% of her time in year 1 and 30% of her time in year 2 on the project, analyzing the fecal samples to determine fecal glucocorticoid (FGM) and immunoglobulin-A (IgA) concentrations.

Catherine Razal, Research Assistant, received her B.S. in Ecology and Evolutionary Biology from the University of Arizona. She has extensive zoo and aquarium experience, working at the Point Defiance Zoo and Aquarium as an intern and Assistant Aquarist; serving as an intern and Research Assistant at Walt Disney World's EPCOT, The Living Seas; volunteering as a Research Assistant at the San Diego Zoo Institute for Conservation Research; and, serving as an Experience Guide at the Phoenix Zoo. Ms. Razal will spend 1,000 hours in Year 2 assisting with analyses of behavioral and animal health data; performing data collection, data management, and data tabulation for assigned research; and, assisting in development of ideas for new behavioral protocols and computerized data management systems.

A Post-Doctoral Fellow will be hired for two years and will spend 100% of his or her time on this project. This position will be responsible for all aspects of research including behavioral data collection, communication with collaborators, data analyses and preparation of scientific papers. The position will assist Dr. Miller and Dr. Whitham in training CZS staff, interns and volunteers in specific data collection and management techniques for assigned research. Candidates for the position must hold a Ph.D. degree in biology, psychology or a related field and have one year's experience in zoo or aquarium research.

Budget
CZS is requesting a grant of $422,365 for this project. The request includes salary and benefit support for Dr. Miller, Dr. Whitham, Ms. Bryant, and the Post-Doctoral Fellow in Years 1 and 2 and for Ms. Razal in Year 2. In Year 1, we are requesting all equipment costs, including Sony Handycam video recorders with tripods, Hard Drives, analysis kits for Corticosterone EIA and Fecal IgA, and disposables (pipette tips, plastic tubes, glass tubes etc.). No equipment or supplies will be purchased in the second year. Costs for shipping of equipment and hard drives, conference travel, and conference registration are also being requested. Finally, CZS has a federally negotiated indirect cost rate of 70.84%, and we are requesting 20% of indirect costs in both years.

PROJECT RESULTS

The proposed study will benefit *all* types of animal care facilities but will be especially valuable to AZA-accredited organizations charged with proactively addressing welfare issues and enriching the lives of individual animals. The zoological community has been seeking an affordable, user-friendly tool that can be integrated into internal welfare review processes. In fact, AZA's Accreditation Standards (AZA, 2013) now require facilities to establish Institutional Animal Welfare Processes (IAWP) to investigate welfare concerns raised by staff members. Although AZA's Animal Welfare Committee has promoted the development of instruments to aid in these audits, WelfareTrak® is the only tool designed to regularly track how individuals in a collection are negatively *and* positively influenced by certain conditions, events or practices. WelfareTrak® allows zoo staff to quantitatively assess the impact of management decisions (e.g. changes in housing) by flagging cases of both deteriorating and improving welfare. If individuals are tracked over time, WelfareTrak® can even be integrated into decision-making processes regarding euthanasia to ensure that guidelines include more than clinical assessments of health (Lambeth et al., 2013). While we have spent the past several years consulting with experts from the international zoo community to generate and test the WelfareTrak® system, the current study will allow us to demonstrate its reliability and validity. We expect that this project will lead to a systemic change in the industry, as we will provide evidence that zoos can benefit from a resource that has not been tapped to its full potential: zookeeper expertise and experience.

In fact, we expect that WelfareTrak® will enhance each facility's – and each zookeeper's – capacity to improve individual animal welfare. To evaluate whether the introduction of this tool results in increased knowledge, improved skills, novel behaviors or shifts in attitude, each participant will complete the Approaches to Welfare Monitoring Questionnaires. For example, to determine whether WelfareTrak® provides zookeepers with a greater knowledge and awareness of species-specific welfare indicators, we will pose questions such as, "what do you believe are indicators of good welfare in chimpanzees?" To determine if individual staff members actually modify their behaviors, we will include items like, "over the past six months, how often have you made changes to an animal's environment to improve welfare?" We will compare questionnaire responses to behavioral and physiological measures of individual animal welfare to ascertain whether perceived changes are linked to actual shifts in welfare status. Finally, we will ask questions such as, "did you learn anything about your coworkers?" to examine whether WelfareTrak® promotes communication within workgroups, as 81% of users reported during beta testing.

The results of this project will have far-reaching effects not only for chimpanzees but potentially for all captive species. At the end of the grant period, we will upload the final version of the chimpanzee welfare survey to the WelfareTrak® system. This survey will include indicators of physical, mental and emotional health with high levels of inter-rater reliability and construct validity. AZA's Chimpanzee SSP, coordinated by Dr. Ross, will encourage each member organization to monitor the individuals in its collection. Dr. Ross also works closely with sanctuaries such as Chimp Haven, a partner in this project that is home to over 200 individuals retired from biomedical research, the entertainment industry and private ownership. In addition, Dr. Bloomsmith will promote the tool at NIH-funded primate research centers, as recent recommendations from the NIH Working Group highlight the need for individualized approaches to chimpanzee management (NIH, 2013). Overall, we expect there to be high demand from a variety of facilities. Indeed, WelfareTrak's informational website (https://www.welfaretrak.org) already receives considerable traffic from animal care professionals working for conservation centers, wildlife sanctuaries and laboratories in the U.S. and abroad. Visitors to the site - whether they work with mammals, birds or reptiles - will have the opportunity to review the results of the current project. If we can demonstrate that WelfareTrak® enhances the welfare of chimpanzees - a species represented by individuals with highly unique needs, personalities and preferences - this will offer convincing evidence that the tool can be applied effectively to other species.

We anticipate that WelfareTrak® will revolutionize the zoo industry's ability to continuously improve animal care and management. While this is a research project, WelfareTrak® is designed to be a management tool for internal use - not to compare individuals across, or even within, facilities. After demonstrating WelfareTrak's construct validity on a model species, we expect a dramatic increase in interest (and registrations) for monitoring additional species, making WelfareTrak® a self-sustaining system. We currently have 20 welfare surveys available for use - from geckos to gorillas to macaws. Our informational site includes an online Survey Library that lists all exisiting welfare surveys. CZS does charge a nominal registration fee, which allows for an unlimited number of Raters to monitor an unlimited number of animals *and* includes access to an online training manual. Those interested in monitoring a species NOT included on the list have one of two options: 1) creating a customized survey, or 2) hiring CZS to recruit experts from the international zoological community to develop a WelfareTrak-certified survey. We also offer "support packages" and in-person training sessions. Fees collected for registration, new survey development and training will cover site maintenance costs, ensuring the sustainability of the system for years to come.

Ultimately, we expect WelfareTrak® to better the lives of individuals living in *all* types of captive settings: from zoos to sanctuaries to rehabilitation centers. By implementing WelfareTrak®, facilities will have the opportunity to intervene rapidly when welfare issues arise, resulting in improved health, longevity and quality of life for all captive animals.

Chicago Zoological Society
Validating WelfareTrak® as a Tool to Improve the Welfare of Individual Chimpanzees
Schedule of Completion
Year 1

	2015	2016										
	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Postdoc Recruitment	X	X										
WelfareTrak Chimpanzee Survey Development	X	X	X									
Approaches to Welfare Monitoring Questionnaire - Baseline Period		X										
Video Creation on Data Collection Techniques		X										
Staff Training on Data Collection Techniques			X									
Random Sampling Subjects			X									
Shipment of Collection and Video Supplies			X									
Baseline Period Behavioral Data Collection				X	X	X						
Baseline Period Physiological Data Collection				X	X	X						
WelfareTrak Implementation							X	X	X	X	X	X
WelfareTrak Period Behavioral Data Collection							X	X	X	X	X	X
WelfareTrak Period Physiological Data Collection							X	X	X	X	X	X
Shipment of Fecal Samples							X			X		
Shipment of Video Data							X			X		

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Schedule of Completion

Year 2

	2016	2017								
	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Shipment of Fecal Samples	X									
Shipment of Video Data	X									
Approaches to Welfare Monitoring Questionnaire - WelfareTrak Period	X									
Coding Behavioral Video	X	X	X	X						
Analyzing Physiological Data	X	X	X	X						
Data Analysis					X	X	X			
Dissemination of Results								X	X	X