HeronConservation
The IUCN Heron Specialist Group

(Cite as: Kushlan J. A. 2011. Heron count protocols: inventory, census, and monitoring of herons. Heron Conservation. www.HeronConservation.org)

Heron Count Protocols:

Inventory, Census and Monitoring of Herons

James A. Kushlan
PO Box 2008, Key Biscayne, FL 33149 USA

Documenting the occurrence, numerical population status, and trends of herons throughout the world is an essential requirement for their conservation at all geographic scales. The importance can scarcely be overstated as much of the international institutional approaches to bird conservation rely on such information. Population estimates are used to identify Important Bird Areas and Wetlands of International Importance. Population estimates, population trends, and range extent are among the criteria used to evaluate a species' conservation status. National population estimates are used to determine national conservation goals and priorities. Subnational/regional population estimates are used for conservation action at regional scales. Local population estimates and trends are used for protecting and managing local sites and populations.

All population estimates must start locally, with identifications and counts of herons at specific individual sites. Counts can document occurrence, numbers, and, over time, trends. Observing and counting herons need to be done in systematic, repeatable, and analyzable ways. This requires standardized methods. The function of this paper is to provide a common system of methodology for observations, inventory, census, and monitoring of herons.

Types of Counts

'Counting" actually is divided into two parts, the identification of the heron and the counting the number of individual birds of each identified heron species.

The simplest 'count' is actually just the identification of a bird. This is called a Heron Incidental Observation. A Heron Incidental Observation may be reported for an individual sighting or or as a list of all the herons seen in a place at a time. This is called a Checklist. Incidental Observations, both individual observations and checklists can be very valuable, as they document occurrence in a place at a time and therefore provide information on distribution.

The next step in complexity is a count of the number of birds of each species present in a place. Counts may be made of individuals or of nests. The methods are the same: each individual or nest is identified to species and recorded. Counting individuals is not as easy as it may seem, and care and practice are needed. The use of field guides and photography for difficult species is urged, as some herons in some plumages are not easily identified to species. The appropriate method for determining the number of herons nesting is to count the nests. It is not acceptable to count only the adult birds seen at a colony site or the number of birds coming and going from a site and consider that to be a count of the birds nesting – it is not. Nest data are not reported as "pairs," as these were not actually counted. They are reported either as nests in some applications or as the number of birds nesting, which is the number of nests times 2. The number of nests is multiplied by 2 to give the number of herons nesting, and this is what is reported. A comment should be inserted to document the calculation. It is often the case that some individuals cannot be identified, perhaps due to their location or similarity among species and so forth. Importantly, these are not part of the count; only identified individuals or nests are part of a count.

Counting herons may be done for purposes of occurrence, inventory, census, or monitoring. These terms must be used precisely so that the function of a count is not misunderstood by either those collecting or using the data. Occurrence, as noted above, is the recorded presence of a species in a place. Inventory is counting the approximate numbers of species in a place. Inventory is done through various means of estimation, including counting as best one can in a single un-repeated attempt. Inventory counts may be, and usually are, estimates. Census is establishing an estimate of numbers in a way such that the count is corrected for observer bias. Monitoring is the use of replicated counts over time to calculate a trend of numerical change. Both census and monitoring requires repeated counts. These are counts done in a way as to be able to calculate the observer bias, which then can be used to correct the raw count data and provide a less biased count. The most usual, and recommended, approach for herons is the double count. Double counting techniques allow a calculation of error, and therefore provide a count that can be used to assess population size

Counting can be done within a zone around a point, called a Point Count or a Stationary Count, or within an area, called an Area Count. A Stationary Count involves the identification of species or counting individuals around a stationary observer. Usually an estimated effective radius of the count is known or a standard radius used, but this is not required. An Area Count, on the other hand, involves the identification of species or counting of individuals over a specifically known area, generally done by the observer moving through the area being counted.

An Inventory most basically involves an enumeration of the species present, which provides a Checklist for that site or area. A collection of sites at which the species is present can be up-scaled to determine the range of that species. Checklist data collected at the same site seasonally can be used to show breeding season, migration, and non-breeding season ranges. Inventory using an unrepeated count provides an estimate of the numbers of each species present. All census and monitoring actions must use repeated counts.

Appreciating the difference between unrepeated counts and repeated counts is critical to designing and carrying out counts of herons. Unrepeated counts, no matter how good they may seem, can only be used for inventory purposes. Inventory data can be used to provide information on sites, species presence/absence and distribution, and approximate population size. Such data are of importance in many applications. However, unrepeated inventory counts cannot give an unbiased estimate of numbers and therefore are not used to assess population size nor for monitoring. Repeated counts, on the other hand, can be used for census and monitoring purposes such as conservation status assessment and trend analyses.

Given these considerations, five variations in ways of counting herons are recognized:

1. *Heron Incidental Observation*

2. *Heron Stationary Count- Checklist or Inventory*

3. *Heron Stationary Count – Census*

4. *Heron Area Count - Checklist or Inventory*

5. *Heron Area Count - Census*

Methodological Considerations

In this section, various aspects of the methods involved in the heron counting protocol will be discussed individually. The following section provides the explicit protocols for the five types of counts.

Heron Incidental Observation

A Heron Incidental Observation is the report of species of herons in a place at a location, either a report of a single species observed or a checklist of all the species observed. There is no areal extent associated with a Heron Incidental Observation. Knowing the location of the site of the observation is critical and is documented as latitude and longitude. Of most importance in this is for the observer to be able to identify all the species present, because as noted above only unambiguously identified birds may be reported. Photography can sometime help to identify an individual to species after the count is completed. In fact, of course, photography is an excellent way to document the occurrences being reported. Heron Incidental Observations are the raw material for determining seasonal occurrence and range for a species. Generally, creating a Checklist of herons should not be encumbered by recording additional observations, such as behavior or conditions. These should be done at another time. The exception is that breeding at a site should be noted.

Stationary Counts

The Stationary Count, also known as a Point Count is conducted from a central point at which the observer stays through the count of a circle surrounding the point. Stationary counts can be used for foraging areas or for breeding areas, to provide a checklist of species present, an inventory count, or a census count. The location is recorded as the latitude and longitude of the central point. A Stationary Count may be done without reference to the radius of the circle being observed. However, it is more valuable if an effective radius is determined and this converted to areal extent. In this case before or after the count, the radius of a count circle around the center point is decided and recorded in meters. Because it is desirable that the radius be easily replicated among censuses, standard radii should be used if possible. The two most commonly used radii for Stationary Counts are 25m (used in many studies) and 400m (used in the USA Breeding Bird Survey), both designed primarily for census of small birds that are both seen and heard. In most counts of herons, observers will need to see the heron. Therefore the radius for any count is related to the distance of open area in which herons can be seen by eye, binocular, and spotting scope. The point count radius chosen should be as large as is practical for the site. Where applicable, the recommended radii for point counts of herons, depending on site condition, are 50m, 100m, 200m, and 400m. The exception to the rule that herons are counted by sight is the count of vociferous cryptic species, such as bitterns, which are identified and counted by their calls. For a Stationary Count, although difficult, the effective radius should be determined for calling counts. For Stationary Counts that are associated with a known radius, the calculated area covered should be recorded and reported.

Area Count

The Area Count is conducted by covering an entire known area. This usually needs to be done by the observer moving through the area so that it is covered thoroughly. Importantly, whatever area is chosen, all parts of it must be examined. In the ideal situation, the entire area is observed in sufficient detail to have been able to record what species of herons are there, and, if counting, to enumerate the numbers of each species present. Area Counts can be used to provide a checklist, an inventory count, or a census count. Counts may be made of birds or nests. Area Counts are generally the best approach for counting breeding sites. The area may be on land or in the water. The location is recorded as the latitude and longitude of the approximate geographic center of the area being counted. Generally, the area to be counted should be determined by considering what will be most meaningful in assessing the herons of an area. The measured extent of the counted area must be determined; this can be done from on the on-the-ground measurements or estimates, maps, Google Earth, or some other objective method. If the area extent is to be calculated after the census, sufficient information on the area covered needs to be collected during the census to do this calculation a posteriori. If possible areas for Area Counts should be of standard sizes. These are 7,800 m^2, 31,000 m^2, 125,000 m^2, and 500,000 m^2; these correspond to the areas of the standard Stationary Count radii. To sample a large area, samples can be taken. When possible, these should be of equal size and they should cover the variations within the landscape. It is often convenient to lay out samples as transects of a given and consistent width. Samples should together cover no less than 40% of the populations at the site. The average numbers in these samples can be expanded to a population estimate by multiplying average number per area by total area. If the number of samples are adequate, a standard error can also be calculated, which is of value as an indication of precision of the count. To determine the number of samples needed for statistical analysis, calculate the coefficient of variation progressively through the census and stop when the statistic does not change. In most situations this is neither needed nor practical. The most important step is to know and record the extent of the area being observed or counted.

Unrepeated Counts

An unrepeated count is a best guess estimate of the number of each species present around a point or within an area. It is made by identifying species and determining how many of each occurs. The resulting data are a list of species and the numbers of each species. No doubt all care will be taken to make the count as exact as possible. However, any count, no matter how careful, will seldom be exactly accurate. So all unrepeated counts should be considered estimates. Either the number of individuals or number of nests may be recorded. As noted above, the number of nests is doubled to estimate the number of nesting birds. There are many ways of doing doing an inventory count. A bird-by-bird or nest-by-nest count of all those seen is the usual method. But if numbers are large, some birds are less than visible, areas are inaccessible, and so forth, estimates can be made. Counting large numbers of birds one by one is impractical. In these cases herons are generally counted in practical increments, by 10, 25, 50 or even 100 birds. This may take practice and training, but with experience can be done. The unrepeated count is usually the case of something being better than nothing.

Such unrepeated count can provide only an estimate of the numbers present. It is a biased estimate in that the error of that estimate is not calculable. In reporting, the unrepeated count is usually documented as a best estimated number. However, the confidence in the data may better be represented by reporting a count band. The following count bands are the standards for herons: 1, 2-9, 10-49, 50-249, 250-999, 1,000-2,499, 2,500-4,999, 5,000-9,999, 10,001-39,000, 40,00-100,000. These bands are generally consistent with IUCN/BirdLife population bands and reflect the realities of counting herons in the field. Unrepeated counts are acceptable only for inventory, but not for census or monitoring purposes.

Repeated Counts

The most important aspect of repeated counts is that data are collected in a way that allow the calculation of detectability error –arising from the fact that nearly every count has an error associated with it. Hardly ever is it possible that are all birds seen, identified correctly, and counted correctly. In experiments, even the most obvious of counting situations produces error. Detectability differs among species, activity and behavior, habitat, season, weather conditions, time of day, skill of the observer, even age of the observer, and more factors than are useful to list. It is not possible to hold even a few of these variables constant, so the best approach is to not to try, but rather to accept that detectability will vary and that it be measured for each count. The actual count can then be corrected. Overall this is rather simple arithmetic, as shown below. Of course, analyses can get more complicated through the use of and testing of various models and trend analyses. But, detailed knowledge of these analytical uses of data is not needed by those making the counts other than to know that repeated counts are required for data to be useful for census or for monitoring purposes.

Repeated Count consists of more than one observer participating in a count at the same time. The differences between the two observers' counts are evaluated to determine how many birds were not seen and then used to calculate the actual population. There are several repeated count methods, but the one recommended for herons is the double observer. The double observer count requires two observers counting simultaneously. There are two double count methods. In the first method, the first observer identifies the species and counts the birds; the second records these sightings and adds to them those that were not seen by the first observer. In a colony count, the first observer can mark each nest and the second will remove the mark and record those unmarked. The number of individuals or nests reported by both observers (this is called X_{11}), the number of birds or nests reported by observer 1 but not by observer 2 (X_{10}), and the number of nests reported by observer 2 but not by observer 1 (X_{01}) are tallied. In the second method, each observer independently identifies and records birds, a comparison of the two records show how many birds were missed by one. The first method will generally be the more useful because the second method requires that throughout the census individuals are recorded (perhaps mapped) in such a way that they are clearly distinguishable so that non-overlap can be calculated. Because of this, the situations where Method 2 will work are limited. The calculations are the same in both methods. The entire area of interest does not need to be counted by the same duo of observers. This is because the bias of each counter is calculated and the individual count corrected. So it is possible for teams to be used to cover an area simultaneously, thereby limiting disturbance.

The following shows how to use the double count data to correct for bias. It illustrates four two-person observer teams counting a colony of two species. Note that the biases were different for the two species and for different observers, but these biases were accounted for in the correction. The corrected figure is rounded down to the next lowest whole number. Note that the second species shows that when there is no bias, the actual count is not affected by the correction. In this example, the counts were of nests. The corrected count for species 1 is 228 birds and that for species 2 is 21 birds, which are the figures, rounded down, that would be reported.

HERON SPECIES ONE						
variable	definition	Team 1	Team 2	Team 3	Team 4	Total
X_{11}	Birds detected by both	55	66	63	32	216
X_{10}	Birds detected by Observer 1 but not by Observer 2	1	2	2	1	6
X_{01}	Birds detected by Observer 2 but not by Observer 1	1	3	1	1	6
P_1	Detection probability for Observer 1 $=X_{11} / (X_{11} + X_{01})$	0.982	0.957	0.984	0.970	0.973
P_2	Detection probability for Observer 2 $=X_{11} / (X_{11} + X_{10})$	0.982	0.971	0.969	0.970	0.973
P_{1+2}	Detection probability for Team $=1-(1- P_1) (1- P_2)$	0.9997	0.9990	0.9995	0.9991	0.9993
N	= team's total detections/ team detection probability $=(X_{11} +X_{10} + X_{01})/ P_{1+2}$	57.02	71.07	66.03	34.03	228.2
HERON SPECIES TWO						
variable		Team 1	Team 2	Team 3	Team 4	Total
X_{11}		6	9	6	0	21
X_{10}		0	0	0	0	0
X_{01}		0	0	0	0	0
P_1		1.0	1.0	1.0	1.0	1.0
P_2		1.0	1.0	1.0	1.0	1.0
P_{1+2}		1.0	1.0	1.0	1.0	1.0
N		6	9	6	0	21

Aerial Counts

Herons may be identified and counted from an airplane. However, counts taken from an airplane present many special difficulties, namely that except for rare situations they are overall fatally inaccurate for both species identification and numbers estimation. Dark species of herons are notoriously difficult to impossible to identify and to count, even large ones. Cryptic species are never identifiable unless they happen to fly. Even small white species can be readily mis-identified, and so are often lumped together in a meaningless category such as ‘white egrets,” a number that has no value for species or site conservation. Aerial Counts can be configured as repeated counts by using two observers who conduct a double observer count just as on the ground, allowing the error associated with the counters to be calculated. However the situation within the plane is such that the two observers can seldom be arranged to so as to double count the same area and should they do so there is no way to determine the numbers of individuals not seen by either or both, and therefore to calculate bias. Generally a two observer methodology serves to enlarge the field of observation in a unrepeated way. And additional problem is the unanalyzable bias. Although this exists on the ground, it is less severe there than in the air. Some birds are not countable from the air because they are not visible at all. To account for all biases, aerial observations have to be calibrated against information from ground observations for each area, species and condition. This can seldom be done; and if it could it is not clear what would be the need for the aerial count in that ground count data would be available. Aerial counts are Area Counts, generally done along a transect, the area being defined by the altitude of the plane and the visual field of the observers. Counts of most colony sites have huge errors of identification and counting, unless the colony is two dimensional, the species are few, large, and obvious. Overall, there are very few applications in which aerial counts are justified. As an inventory tool aerial observations can provide important information on the sites of heron colonies or concentrations, for subsequent counting on the ground. There also are some areas that are inaccessible other than from the air. If it is determined that population information is needed and can be collected in no other way, aerial observations may be better than no observations, especially at an early stage of gaining information about an area. Aerial counts are reportable as an inventory not as a census or monitoring, even if done by two observers. To suggest the inherent error, numbers are best reported within bands; and only species that are unambiguously identified are reported. An aerial count that attempts to use double observer methods needs to be able to demonstrate exactly what is being achieved. All this suggests that Aerial Counts generally are of limited value for the inventory of herons, and nearly worthless for census or monitoring for most species of herons in most situations. However for areas not otherwise accessible and situations not otherwise counted, some inventory data are better than no inventory data.

Photographic Counts

There are situations where photographs can be taken of birds or of nests, either from the ground or from the air. These can be counted later in more controlled conditions than in the field. Unfortunately, in most situations, this will not produce acceptable count results as the errors in identifying species, observing hidden birds or nests, and counting itself are very large. There is an advantage of photographs over real-time counts in that the count can be redone, and precision can be determined. There are a limited number of situations where there are no hidden birds or nests and the species can be identified unambiguously. These situations include single species colonies, roosts, or feeding areas that are two-dimensionally spread over the ground or high in the tops of trees with no understory nesting. Such counts are area counts. The birds or nests shown in the photographs in the situations where there is no hidden nests can be counted using double observers to account for counting bias. Attempts have been made to determine mathematical relationships between aerial and ground counts. The correlation between ground and air counts is not very good or consistent over magnitude of counts, as most situations are underestimated in varying degrees and the degree of under-estimation depends on the magnitude of the counts. The problem is that, observer error, observer differences, correlation error, and site differences lead to intractable compound errors.

Calling Counts

The exception to the rule that herons are counted by sight are the cryptic species particularly bitterns, which call at night in some seasons and can be counted by their calls. The count can be done as a Stationary Count or an Area Count. It is permissible to play taped calls to incite a call back. Issues of detectability, of course are magnified, but the basic protocols are the same. Developing protocols for calling counts, applicable to bitterns, is underway. See references in the bibliography, below. Calling count protocols may be accessed on the HeronConservation website.

Flight-line Counts

This is an unfortunately commonly-used technique, counting birds flying by or coming into a roost or colony. It is used because it is easy. But there are many errors and studies have not shown any validity to the method. If the bird numbers are large, the flights are usually large and rapid and the counts instantaneous and difficult. This leads to errors in both the numbers and in the identifications. Birds tend to come and go from a site, so subtracting birds flying out of the site is needed. If the location being counted is a colony, there is no proven relation to numbers of birds entering and leaving and the number of nests, as there are numerous non-nesting birds in most colonies. Usually not all the flight lines coming into a site can be counted from one location. If this is the case, the count is done in sectors and this leads to a problem of overlap and double counting. Essentially, in flight-line counts, there is no way of knowing what is being counted. There are very few applications where flight-line counts are justified, generally in situations where for logistic reasons there is no other choice and in addition can be done completely. Even in this situation, the data can be used as a species Checklist and as an inventory estimate but they are not usable for census or monitoring purposes.

Breeding Colony Counts

This is one of the most important uses of counting, as it provides an estimate of the species breeding at a site and their numbers. As noted above, counts may either be of birds or of nests. Counts of birds do not translate into a breeding population estimate, as the individuals counted may or may not be breeding. Counts of nests are an instantaneous measure of the nesting population. Only nest counts produce an estimate of the numbers of herons nesting. Where nesting is prolonged, especially when different species have different phenology, nest counts may need to be repeated throughout the season. Where nesting is a year round phenomenon, this can become exceedingly complex. A season-long population estimate can be derived from the individual replicated counts in two ways. The first is to use the highest number in any count over the season, which is usually an underestimate unless a species is highly synchronized and re-nesting does not occur. The second is by marking nests and then counting only unmarked nests in subsequent counts, which is still an underestimate if nests are reused.

The two main concerns with colony counts are identification and disturbance. Identifying and counting herons nesting is done in one of four ways. The first is for the observer to note the species of bird as it is on or rises from each nest. For many species eggs can be distinguished, and so can be counted by looking in the nest either directly or using mirrors on a pole. However, it is not always possible to identify eggs of closely related heron species of similar size. Third, species can be identified when small young are in the nest. If it is possible to control timing of the count, this is the best time to count a colony as the herons are identifiable, young remain at the nest, and the count is of the number of nests that actually produced young, a reasonable surrogate for nesting effort for a population for the season. Because of non-synchronous nesting timing over the colony, generally the count is made by combining these three approaches. The fourth method is to count the birds to species and then count the nests, dividing the number of nests proportionally among the species. This method has unaccountable errors and is useful only in colonies with few birds and few species.

The issue of disturbance is always to be considered. Herons tend to depart their nest when approached, leaving their eggs or chicks exposed to heat, cold, predators, and nest material robbers. Counters should time their work in colony sites to moderate conditions, when it is neither too hot or too cold or rainy, too early nor too late in the day. Time in the colony should be kept to a minimum. That is, more observers for shorter time are better that few observers over a longer time, and that the effects of predators need to be monitored perhaps causing the count to be abandoned. In most situations, herons are quite resistant to disturbance, more so than many other colonial nesting waterbirds. An important generalization is that more a colony of birds has been exposed to mild disturbances the less disturbed it will be during a count. So heron colonies near human activities or which have been entered frequently in a nondestructive way may be relatively immune to disturbance effects. The real key to minimizing disturbance is to spend as little time as possible making the count.

A breeding colony count consists only of the nest count. Collecting other data such as habitat variables or data for research purposes should not be done at the same time as a count. Such data collection prolongs the time of observers in the colony to the incremental detriment of the birds and young and distracts from the counting, thereby increasing its error. Other data collection is done at other times, and this information is stored in other ways and is used for other purposes.

Monitoring

Monitoring is the gathering of information and its assessment to show trends in population. Such trends can be local, regional, or global. The Heron Count Protocol aims at population size estimation and trend, because population size and its change are standard criteria for international conservation policies and programs. So most monitoring is based on counts. Monitoring of populations using count data requires that the data be collected in such a way as to be correctable for count bias. Thus only corrected data from repeated counts, such as double counts, are used in population monitoring based on counts. Monitoring programs can use Stationary Counts or Area Counts. To be effective, monitoring of populations requires counts be conducted as much as possible in the same way and timing in succeeding years or seasons, so as to further reduce variability. The amount of uncontrolled variation in counts to be used for monitoring purposes influences the ability to discern trends statistically. The power of a monitoring procedure to reveal changes in populations needs to be calculated so as to determine if the program can achieve its predetermined goal of showing a trend of a given magnitude. There is no reason to monitor if the data being collected are not sufficiently sensitive to the underlying population trends as to be of conservation value. Developing and maintaining over time a valid population count monitoring program are not trivial undertakings. It is time consuming, expensive, and requires institutionalization. But monitoring is expected of those with conservation responsibilities for heron populations.

Indices

Although counts are required for population estimation, population estimation is not required for assessment of population trend. Rather than counts, a monitoring program might be designed around an index, which is a measurement that bears a proven consistent relationship to the underlying population size and varies in the same way. For some conservation purposes, indices should suffice. Indices are useful at two scales, local and regional. Locally, changes in an index being measured regularly at a site should provide local managers with useful information on the populations they are responsible for. Regionally, index trends from a geographically expansive monitoring program should provide useful information on regional population trends and perhaps permit inferences on changing habitat conditions. The best example of a regional monitoring program for herons is the British Trust for Ornithology Heronries Census, which started in 1928 and provides an index of the Grey Heron population. The annual monitoring program is complemented periodically by a special survey to count all sites, thereby providing information to calibrate the annual survey. At present, there is no index of abundance for herons that can be used universally. The development and testing of regional and nationwide indices would be a welcomed development, as in general the collection of index data is more easily and cheaply done than the collection of census and monitoring counts. As a result, indices can be effective because they actually can be accomplished in situations where counts are too expensive, too manpower intensive, or otherwise too difficult. This does not mean that any sort of measurement is an appropriate index, and the continued collection of uninformative and untested data is to be not supported. The only indices that should be used are those that meet the criteria of being provably correlated with population changes and are being collected with sufficient frequency and geographic scale as to provide analyses useful to heron conservation.

Heron Count Protocol

Heron Incidental Observation

Data to be collected: Location: latitude, longitude; nation, state/province. Observer: name of observer(s); number of observers. Date: month; date; year. Time: start time in hours and minutes. Identification: species of heron. **Protocol:** record required location, time and personnel data; observe and identify heron(s); photograph is appropriate for documentation; submit information to eBird. Heron observations may be of single species or a checklist of all the species at a site.

Heron Stationary Count- Checklist or Inventory

Data to be collected: Location: latitude, longitude of the center point of the counting circle; nation, state/province. Observer: name of observer (s); number of observers. Date: month; date; year. Time: start time in hours and minutes; duration in hours and minutes. Area: If known (but not required), the area of the area observed as calculated from the effective radius of the observation area. Identification: species of herons. For checklist, identify all species. For inventory, count or estimate the number of each species. **Protocol:** Choose center point of the count circle; if applicable choose radius of the count circle; record required location, time and personnel data; standing at the center point identify all the herons to species. For inventory, count or estimate the number of herons or nests of each species. For nest count, multiply number of nests by 2. Record in comments: "Nesting colony: heron numbers based on nest count following the Heron Count Protocol." If counts were recorded within population size bands, enter the midpoint of the band and record in comments: "Numbers represent midpoint of population size bands following the Heron Count Protocol." If applicable, record in comments the area as calculated from the effective radius of count circle.

Heron Stationary Count – Census

Data to be collected: Location: latitude, longitude of the center point of the count circle; nation; state/province. Observer: name of observer(s); number of observers. Date: month; date; year. Time: start time in hours and minutes; duration in hours and minutes. Area: If known (and this is recommended for a census), the area of the area observed as calculated from the effective radius of the observation area. Identification: species of herons and number of each species using a bias estimation protocol such as a double observe count. **Protocol:** Choose center point of the count circle; if applicable choose radius of the count circle; record required location, time and personnel data; standing at the center point identify all the herons to species; conduct a double count or conduct another bias estimation of the number of herons or nests of each species. In a double count, the first observer in a systematic way identifies and makes known to the second observer each bird identifying it to species. (Species and numbers reported by the first observer are recorded by the second observer, who also records birds not seen by the first observer. The numbers of birds seen by both observers and only by each observer are tallied. The corrected census is calculated for each species for the area and recorded.) Calculate the corrected count. Record in comments: "Count based on double count, corrected for bias following the Heron Count Protocol." If another protocol for bias estimation is used, document that instead. For nest count, multiply calculated number of nests by 2, submit the calculated number of herons nesting and record in comments “Nesting colony: heron numbers based on nest count following the Heron Count Protocol.” Also record in comments the area calculated from the effective radius of count circle.

Heron Area Count - Checklist or Inventory

Data to be collected: Location: latitude, longitude of the approximate center of the counting area; nation; state/province. Observer: name of observer (s); number of observers. Date: month; date; year. Time: start time in hours and minutes; duration in hours and minutes. Area: Areal extent of location being counted in square meters or hectares. Identification: species of herons; for inventory, count or estimate the number of each species. **Protocol:** Choose area to be counted; estimate approximate center point of the count area record latitude and longitude; determine the areal extent of the area to be counted determining or taking sufficient information to be able to calculate the area counted in square meters or hectares; record required location, time and personnel data; observe and identify species of herons. For checklist identify the species of herons present in the area. For inventory, count or estimate the number of herons or nests of each species. For nest count, multiply number of nests by 2. Record in comments “Nesting colony: heron numbers based on nest count following the Heron Count Protocol.” If species were recorded in bands, enter the midpoint of the band and record in comments: “Numbers represent midpoint of population size bands following the Heron Count Protocol.” Also record in comments the area of the count in square meters or hectares.

Heron Area Count – Census

Data to be collected: Location: latitude, longitude of the approximate center point of the count area; nation; state/province. Observer: name of observer (s); number of observers. Date: month; date; year. Time: start time in hours and minutes; duration in hours and minutes. Area: Areal extent of location being counted in square meters or hectares. Identification: species of herons and number of each species. **Protocol:** Choose area to be counted; choose approximate center point of the count area; record latitude and longitude of center point; determine the areal extent of the area to be counted determining or taking sufficient information to be able to calculate the area counted in hectares; record required location, time and personnel data; moving through the area observe every portion, identify to species the individual herons or nests observed and using the double count method determine the number of herons or nests of each species. (The first observer in a systematic way identifies and makes known to the second observer each bird identifying it to species. Species and numbers reported by the first observer are recorded by the second observer, who also records birds not seen by the first observer. The numbers of birds seen by both observers and only by each observer are tallied. The corrected census is calculated for each species for the area and recorded). Record in comments: “Count based on double count, corrected for bias following the Heron Count Protocol.” If other bias estimation protocol was used, document that instead. For nest count, multiply calculated number of nests by 2, submit the calculated number of herons nesting and record in comments “Nesting colony: heron numbers based on nest count following Heron Count Protocol.” Also record in comments the area of the count in hectares.

Data Archiving

Data should be stored by the observer but also should be submitted to eBird (http://eBird.org). Users need to register with eBird and should also record their usual count locations for future use. Counters can then use their user name and password for access, including their list of count sites. To contribute an observation or count, access the data base entry forms going to the HeronConservation website (www.HeronConservation.org).

Procedures within eBird:

- Go to eBird Log-in Page. Register, if not already.
- Enter and maintain your list of count locations using latitude and longitude, decimal degrees. Identify the location of the count from your list.
- Enter date, start time, duration, area covered (in hectares), and number of observers.
- Select the species and enter the numbers counted:
  - For a single species observation or checklist, enter an X next to the species observed.
  - For an inventory count, enter the best number for each species.
  - For a census count, enter the number of birds corrected for calculated bias.
  - For a colony nest count, multiply the number of nests by 2 and enter the quotient as the number of nesting birds.
- Confirm entries and add required notes to conform to Heron Count Protocol. If the species counts were recorded in bands, add to the notes the words: "Bird numbers derived from mid-point of inventory bands following the Heron Count Protocol." For a census count, add to the notes the words: "Count based on double count, corrected for bias following the Heron Count Protocol." For a colony nest count, add to the notes the words: "Nesting colony: heron numbers based on nest count following the Heron Count Protocol." Also, record in comments, if applicable, the area of the count in hectares.

It is also possible to import data from a spreadsheet or database. This and other information is found on the eBird website.

Within eBird, data summary, exploration and analyses are possible by the observer, once data are entered on eBird. On-line within eBird, one can generate lists and charts of your data. More exhaustive analyses are possible by downloading the raw data from the eBird data sets of the Avian Knowledge Network (http://www.avianknowledge.net).

Acknowledgements

I thank Kathy Parsons, Lisa Sorensen, Brian Sullivan, Ann Sutton, Jeff Washburn, and Jennifer Wheeler for advice. The double count calculation example is courtesy of Ghiselle Alvarado, Kathy Parsons and Jennifer Wheeler. Special acknowledgement is due to eBird and the Cornell Laboratory for Ornithology for their partnership.

Annotated Bibliography

There is a huge literature on counting birds, including counting waterbirds. Below is a small selection of particular pertinence to the protocols for counting herons.

Bibby, C. J., N. D. Burgess, D. A. Hill and S. H. Mustoe. 2000. Bird census techniques. Elsevier, UK. *Well respected synthesis on bird monitoring.*

Breeding Bird Survey. http://www.pwrc.usgs.gov/BBS/about/. *Protocols for Breeding Bird Survey, a monitoring system using point counts along a transect in USA.*

BTO and JNCC. 2011. Breeding birds in the wider countryside. Grey Heron. http://www.bto.org/birdtrends2010/wcrgrehe.shtml. *The long term Grey Heron census in the UK.*

Inventory methods for marsh birds: Bitterns and rails. Standards for Components of British Columbia's Biodiversity No. http://www.ilmb.gov.bc.ca/risc/pubs/tebiodiv/marshbirds/biraml20-03.htm. Calling counts for bitterns.

E bird. 2011. eBird http://ebird.org/content. Information and access to eBird.

U.S. North American Bird Conservation Initiative (NABCI) Monitoring Subcommittee. 2007. Opportunities for improving avian monitoring. http://www.nabci-us.org/aboutnabci/monitoringreportfinal0307.pdf. *Review of bird monitoring in USA.*

Conway, C. J. 2011. Standardized North American marsh bird monitoring protocol. Waterbirds 34: 319-346.

Hutto, R., S. M. Pletschet, and P. Hendricks, 1986. A fixed-radius point count method for nonbreeding and breeding season use. Auk 103:593-602. *Example of small area point count methods.*

Johnson, D. H. 2008. In defense of indices: The case of bird surveys. Journal of Wildlife Management 72:857-868. *The value of properly used indices.*

Lambert, J. D., T. P. Hodgman, E. J. Laurent, G. L. Brewer, M. J. Iliff, and R. Dettmers. 2009. The northeast bird monitoring handbook. American Bird Conservancy. The Plains, Virginia. 32. http://www.nebirdmonitor.org/handbook/nehandbook. *A guide to considerations in planning a monitoring program.*

Marchant, J. H., S. N. Freeman, H. Q. P. Crick, and L. P. Beaven. 2004. The BTO Heronries Census of England and Wales 1928–2000: new indices and a comparison of analytical methods. Ibis 146: 323–334. *An analysis of the longest running index of a heron population.*

Nichols, J. D., J. E. Hines, J. R. Sauer, F. W. Fallon, J. E. Fallon, and P. J. Heglund. 2000. A double-observer approach for estimating detection probability and abundance from point counts. Auk 117:393-408. *Sets out the rationale for the use of double-observer counts.*

Poulin B . and G . Lefebvre 2003 . Optimal sampling of booming Bitterns, *Botaurus stellaris* . Ornis Fennica 80 : 11-20. *Calling counts for bitterns.*

Sorenson, L and A. Haynes-Sutton. 2010. Caribbean waterbird census manual: Promoting conservation of waterbirds and wetlands through monitoring. http://conserveonline.org/workspaces/cwc/documents/caribbean-waterbird-census-manual-promoting/view.html. *Protocols for the Caribbean Waterbird Census.*

Steinkamp, M., B. Peterjohn, V. Byrd, H. Carter, and R. Lowe. 2003. Breeding season survey techniques for seabirds and colonial waterbirds throughout North America. http://www.waterbirdconservation.org/pubs/psgmanual03.pdf. *Draft manual for all waterbirds for the North American Waterbird Conservation Plan – Waterbird Conservation for the Americas.*

Thompson, F. R., III, and F. A. La Sorte. 2008. Comparison of methods for estimating bird abundance and trends from historical count data. Journal of Wildlife Management 72:1674-1682. *Use of old data.*

Waterbird Conservation for the Americas. 2006. Técnicas para Inventarios y Monitoreo de Aves Acuáticas. http://www.fws.gov/birds/waterbirds/Monitoring/NAOCtaller.html. *The workshop from which the example of bias calculation was drawn.*