TECHNIQUES FOR SHIPBOARD SURVEYS OF MARINE BIRDS

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

TECHNIQUES FOR SHIPBOARD SURVEYS OF MARINE BIRDS

INTRODUCTION

The U. S. Fish and Wildlife Service has long been active in population surveys. Data have accumulated somewhat haphazardly over the years; some have been published, some have been archived, but most have been summarized in field and trip reports and promptly filed out of sight and memory. Surveys of marine bird populations have fared better than most, perhaps because of the cost involved in mounting such efforts and the relative uniqueness of each survey. The collection and management of data on marine birds is of vital concern to agencies and individuals interested in coastal and marine ecosystems in Alaska.

Surveys of marine birds in pelagic habitats where they spend most of their lives are an integral part of the assessment and monitoring of migratory bird populations impacted by activities on federal lands as well as by commercial development of the regions physical and biological resources. The Alaska Fish and Wildlife Office of Research has established a data bank for these surveys much along the lines suggested by King et al. (1967) and King et al. (1974). This bank now contains more than 8,000 hours of observations from areas throughout the North Pacific Ocean and from the Bering, Chukchi, and Beaufort Seas. The impetus for the development of these techniques, as well as data formats, codes, and the collection of the original data, came from the research efforts of the Outer Continental Shelf Environmental Assessment Program funded by the Bureau of Land Management. The data bank has already proven to be extremely useful (Hunt et al. 1981, Gould et al. 1982, Thorsteinson 1984) and will become increasingly important as it grows with future contributions. This system will enable resource managers to deliniate critical habitats, monitor populations, and assess possible impacts of coastal developments on marine birds.

A data bank of this magnitude is depend~~a~~ent on contributions from many sources and all of the data must be compatible. The purpose of this manual is to present a standardized set of techniques for censusing birds in oceanic habitats and to provide detailed instructions on their implementation. While this manual deals solely with shipboard techniques, the data bank contains a large number of aerial surveys. The codes and formats presented in this mannual are also for use with aerial surveys. The reader is refered to Forsell and Gould (1981) or Savard (1979) for techniques of aerial shoreline surveys and to Harrison (1982) or Briggs et. al. (1985) for pelagic aerial survey techniques.

SHIPBOARD SURVEYS

Most shipboard investigators of marine bird populations have relied on modifications of line- or strip-transect methods and have reported their results as indices of occurrence or abundance supplemented with anecdotal information (e.g., Jespersen 1930, Wynne-Edwards 1935, King and Pyle 1957, Kuroda 1960, Bailey 1968, King 1970, Shuntov 1972, Gould 1974, Brown et al. 1975, Ainley and Jacobs 1981, Powers 1982). These methods, however, have differed greatly, especially in dealing with such problems as interspecific differences in behavior and conspicuousness. Wiens et al. (1978) analyzed in some depth the problems of detectability in the determination of densities of birds at sea, and suggested techniques that allow for greater control of specific bias-producing factors such as flying birds and determination of distances at which birds are first detected. However, the effort needed to meaningfully reduce the entire suite of biases inherent in transect surveys of seabirds seriously reduces the cost-effectiveness of the surveys and thus limits their usefulness. This is especially true if information other than abundance and distribution, e.g., behavior or age structure, is also being sought. Bailey and Bourne (1972) and Tasker et. al. (1984) discussed the problems involved in counting birds at sea and called for standardization of techniques. Bailey and Bourne (1972) stressed the need to use 10- or 15-minute transects that could be analyzed separately or could be combined, depending on local density and distribution patterns. Tasker et. al. (1984) reviewed the major types of at sea survey techniques and recommended three of the major componets of our system--that of a 300m wide strip census, 10 minute duration, and an instantanious count of flying birds. Our method evolved from attempts to accumulate the maximum amount of information on the distribution and abundance of marine birds as was possible within realistic time, money, logistics, and environmental constraints (Gould et al. 1982). Of primary importance was the establishment of a standardized system that was easy to use and teach, and that would provide consistent results: a system useful for both management (monitoring/inventory) and research programs.

We use modified strip census techniques to develop indices of density (Birds/Km^2/Transect). These indices, while not being "beak counts", are relatively consistent within the data base and provide a baseline from which we can define and interpret fluctuations in the size and distribution of seabird populations both within and between areas and time periods (Forsell & Gould 1981, Gould et al. 1982, Gould 1983). To provide the broadest and most cost effective coverage of any geographic area and yet retain a standardized system, when conditions do not permit the use of strip transects, we use five supplemental techniques: skiff counts, station counts, ship-follower counts, coastline counts, and general observations.

SAMPLING DESIGN FOR STRIP TRANSECTS

Serious consideration and planning should be given to sampling design before leaving port. Once the cruise has begun, the sampling design should not be changed.

Pelagic Areas. There are three stratagies that work well in pelagic areas, depending on the mission and schedule of the cruise: random sampling, serial sampling, and sampling by stratified habitats. Random single transects, or sets of transects, may be conducted throughout the cruise, but the observer should be consistent in the number of transects used during each observation period (e.g., one per hour). Three 10-minute transects in a row (every hour) works well in most situations. Random sampling is useful to observers who have other duties during the cruise and only limited observation time. True randomization, however, is difficult to accomplish since the cruise track is often predetermined and the ship is frequently engaged in other non-related activities. In these cases, randomization becomes based on time rather than habitat or geographic area, i.e., observations are taken at preset intervals.

Serial transects--transects taken continuously for an extended period of time--are used in two situations. They are taken while a ship is transiting between two points, or as radials either perpendicular to a given location (such as a breeding colony) or parallel to it (along or across a habitat such as the ice edge or continental shelfbreak). If only a single observer is available, short breaks should be inserted in the series at predetermined intervals. If two or more observers are available, they should alternate taking transects (hourly), or one can take transects while the other transcribes data and occasionally spells the first observer.

With dedicated ship time, the observer can take sets of transects within each identifiable habitat of the study area. Unfortunately, our knowledge of the oceanography of most areas is limited and it usually takes a considerable amount of sampling to identify and define oceanic habitats. Kessel (1979) has identified major habitat types for Alaska. There are a few fairly reliable clues that can be used to further distinguish between habitats, e.g., major or rapid chanes in surface water temperature, depth, or salinity. The problem of adequate sample sizes has still not been resolved for our techniques. Seabirds are frequently clumped, even within apparently homogeneous habitats, and their patterns of dispersal may change dramatically within relatively short time spans: a density index of 1.0 bird/km^2 at 0800 hours in a given location may change to 1,000 birds/km^2 in the same location at 0900 hours. This is particularly true for species, such as the Short-tailed Shearwater (*Puffinus tennuirostris*), which may occur in very high densities and tend to form enormous, short-term aggregations from many small, wandering flocks. The number of transects needed to adequately form a mean density index for a given area may be as low as 20 or greater than 50 depending on the distribution of birds, the homogenity of the habitat, and the extent of the habitat. We feel a sample of 25 would probably be adequate in most small homogenious habitats in Alaska, but within extremely variable areas such as bays or passes one may need to sample as much as 20 percent of the area to obtain an adequate density index.

Attention should also be given to the temporal distribution of observations. Seabirds are not uniformly active throughout the day, rather they feed, rest, and return to colonies at intervals related to food availability, weather conditions, distance from colonies, etc. Although the squence and periodicity of these behaviors are poorly understood, and almost certainly vary among the different seabird species, they should be allowed for by conducting surveys during as many parts of the day as possible.

Bays. Most bays and passes have quite varied bottom topographies, substrates, and tidal conditions. These factors affect the distribution of marine birds and their foods, and dramatic changes in abundance often occur over very short distances. Transect paths within these habitats should be designed to sample the varied bottom topography by zig-zagging from shore to shore across the area (Figure 1). This assures that all habitats available to marine birds are sampled; hopefully with each habitat sampled in proportion to its availability to the birds. Shoreline habitats are usually under-sampled when following this procedure so that, when possible, adjustments should be made to the cruise tracks which bring the percentage of coastline sampled closer to the percentage of total bay sampled. Consideration of temporal distribution of transects is even more important in bays then it was in pelagic areas; tides, for example, have a great effect on seabird activity within bays and especially passes.

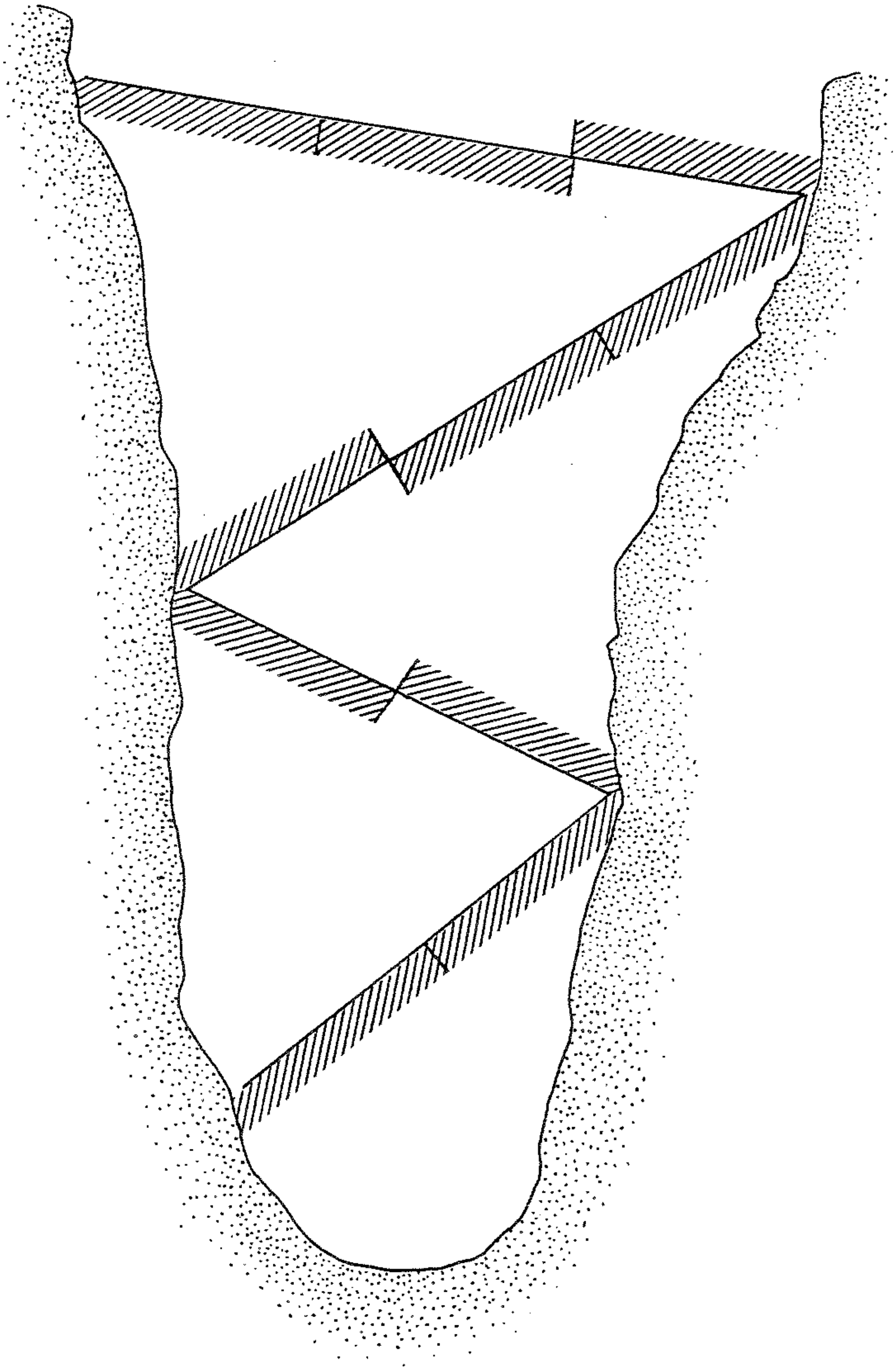
OBSERVATION TECHNIQUES FOR STRIP TRANSECTS

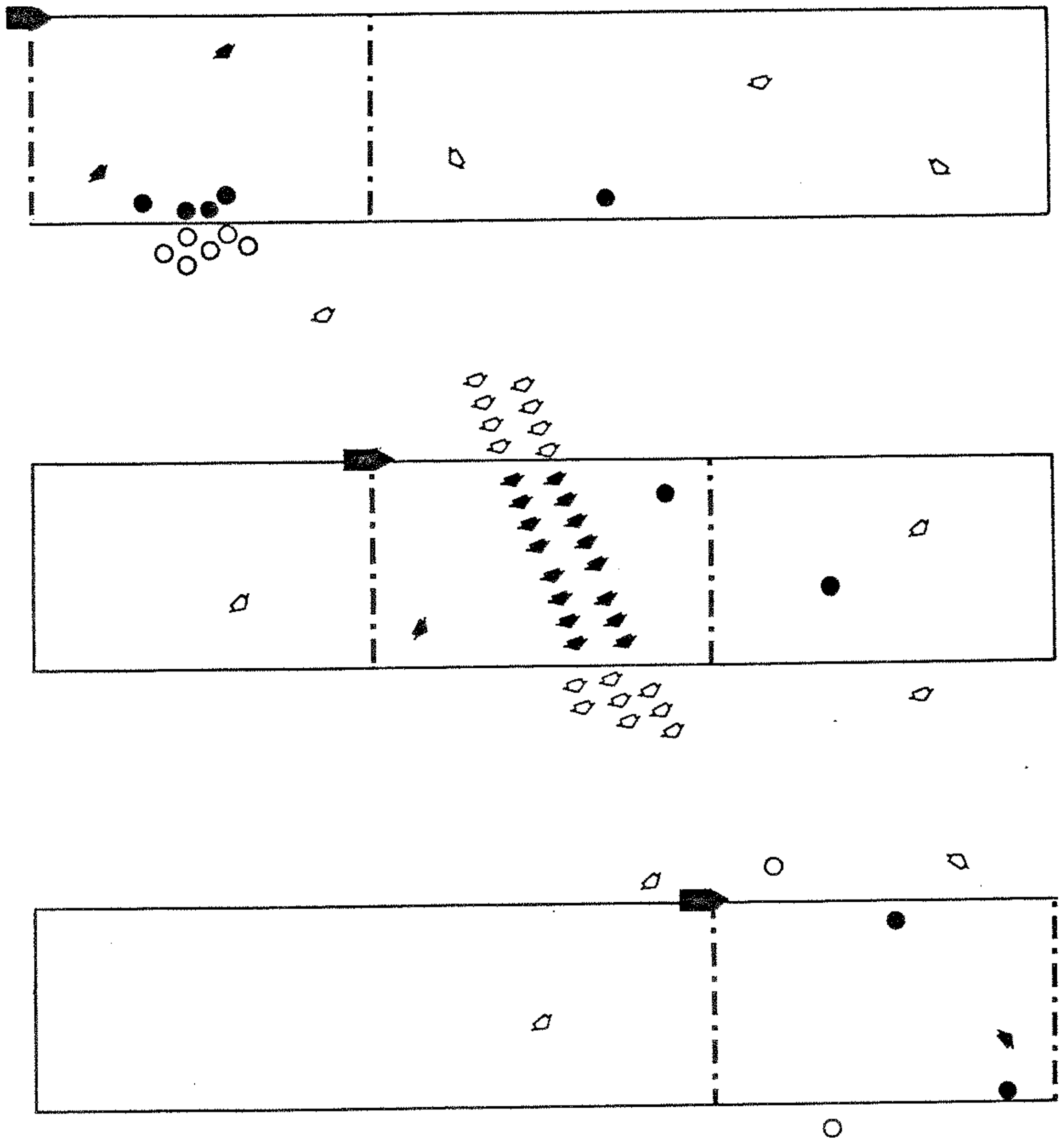
The basic method is for the ship to move along a straight path at a constant speed. For a specified length of time, the observer counts all birds observed laterally to one side out to a specified distance and forward of mid-ship to the end of the transect (Figure 2). All birds associated with the water, e.g., foraging, sitting, circling, milling, and feeding are counted. Birds flying in a direct and consistent manner through the transect, not associated with the water, are only counted during periodic "instantaneous" counts. Each survey unit (e.g., 10 minute counting period) is called a transect.

Area Surveyed. The amount of area surveyed during each transect varies with the speed of the ship, the width of the counting zone, and the duration of the observations. Different ships have different cruising speeds and unless the ship is dedicating time for bird observations, the observer will not be able to control this speed; transects will thus have to be taken at many different speeds. The speed at which the observer moves along the transect probably influences census results, but how it influences the number of seabird detections has never been properly studied nor evaluated. At high speeds, the observer has less time available to detect and identify all birds, especially in areas of high density and areas where birds are feeding below the surface. At slow speeds, more birds may move into the counting zone and become associated with the water than at high speeds, thus inflating the count. It has been our experience that 10 knots is an average cruising speed, and probably the most appropriate speed for pelagic observations. Only under special conditions, such as when there is a lot of ice, do we analyze data from strip transects conducted at speeds less than 6 knots. In order to hold variability in the data within reasonable limits we switch to supplemental techniques (e.g., general observations) at speeds of less than 6 knots and more than 15 knots.

Our standard transect width is 300 m. This width is essentially a compromise between an appropriate distance for detecting all birds under reasonable observation conditions and covering an adequate survey area with limited time and money. Detection of all birds--especially the smaller species--out to 300 m becomes difficult or even impossible when the seas are rough or rain, fog, or reflected sunlight reduce visibility. The height of the observer above the water also affects detection distance and a 300 m width may not be practical from a small boat except under ideal conditions.

Figure 1. Example of cruise tracks and counting zones for sampling a variety of habitats in bays. In wide bays, where more samples may be needed, while transiting the opposite direction a cruise track similar to the dotted line would be followed.





◆ Flying bird; not counted in the transect zone.

◇ Flying bird; counted in the transect zone.

○ Bird associated with the water (feeding, sitting, etc.) not counted in the transect zone.

● Bird associated with the water (feeding, sitting, etc.) counted in the transect zone.

Figure 2. Proceedure for determination of birds included in hypothetical transect with three instantious counts of flying and milling birds.

Surveys using 300-m widths are thus not always possible. When most of the birds cannot be detected out to 300 m, the observer may wish to reduce the transect width to 200 m. If 200 m is too far, then only general observations should be conducted.

The ability to estimate distances is of major importance in conducting shipboard transects. The estimation of distances is principally affected by the height of the observer above the water. An observer 15 m high often overestimates the transect width while an observer only 4 or 5 m above the water often underestimates it. Choose an observation spot as high as possible, especially on small ships; the flying bridge is usually a good choice if it is available and affords a good view of the counting zone. On large ships, the bridge wing may be high enough and far more convenient than the flying bridge. It is rarely advisable to conduct observations from inside the pilot house.

A variety of techniques and equipment are available to aid in the determination of distances, and a primary objective of the observer when first boarding a ship should be to develop an accurate method of estimating the transect width. Most harbors are very accurately charted. Locate several objects that are known distances from the ship (e.g., 300, 500, and 1,000 m) and spend some time looking through your binoculars and getting oriented to the distance. Often you will be able to relate the size of birds to these distances. The relative size of birds on the water is quite helpful. Practicing in the harbor before leaving on the cruise will help put bird sizes to use in judging distances.

Dennis Heinemann (Heinemann 1981) developed a range-finder for pelagic bird censusing that can be very helpful in maintaining consistency in determining the border of the counting zone during transects. A set of dial or slide calipers can be used as the range finder. Instructions for its use are available in Appendix 1. The major limitation of this device is that the horizon must be in clear view; thus, it is not useable in bays or in rough seas. The observer must be consistent in the distance away from the eye that the caliper is held, and this distance should be checked periodically. The up and down motion of the ship adds to the difficulty of using the instrument. The range-finder's accuracy is considerably reduced at heights of less than about 8 m because the angle is so slight that minor differences in the setting will greatly affect the estimate. Always check the range-finder during the cruise with objects of known distances, e.g., other ships or buoys. See also Siniff et al. (1970) for another type of range-finder which you may find useful.

On small ships and where the horizon is not visible, the best technique is to trail a cylindrical buoy or other marker behind the ship so that it is 300 m behind the observer. Use floating line that will not stretch too much and has several hundred pounds breaking strength. It is best to continue to measure the line as it is being deployed so that the stretch of the line will be accounted for. Ship followers often congregate around this buoy enabling the observer to keep track of ship followers as well as to judge the size of birds at a known distance. If the ship's speed is known, estimates of distance can be checked by timing how long it takes to approach a floating object. When the ship is approaching floating objects such as logs, buoys, trash, or even birds, observers should estimate when the ship is an arbitrary distance, e.g., 300 m, and time how long it takes the ship to reach the object. By matching the figures with those in Table 1, observers can check their estimation of distances.

Duration of Observations/Length of Transects. The duration of observations not only affects the amount of area surveyed, but several other important variables, especialy frequency of occurrence. Short transects cover small areas, but provide a large sample size. Long transects are less likely than short transects to miss the uncommon species, thus reducing the sometimes severe problem of accumulating many transects with no birds; many transects without sightings compound the difficulty of analyzing the data. Short transects allow the documentation of bird numbers in rapidly varying habitats and have the advantage of being easier to fit into a tight schedule or into small bays and fjords, while long transects have the advantage of requiring less paper work per set of observations--a not inconsiderable problem. In the past, our transects have been of both 10- and 15-minute durations. We now use only 10-minute transects although it may be appropriate in areas of very low seabird density, e.g., the subtropical central Pacific, to use 15, 30 or even 60-minute transects. Remember that the greater the variability within a data set, the more difficult the data are to analyze and compare with other data.

Counting Birds. Detecting and identifying birds at sea is a talent that has to be developed. Do not depend on your naked eyes to spot birds. Make frequent sweeps of the entire count area with your binoculars. Scanning forward to the end of the transect increases the detection of birds that may leave the area or dive before the ship reaches them. For birds on the water, be sure to count them as far in front of the ship as possible, since they may dive or move out of the transect zone as the ship approaches. Be aware, however, of the passage of time, because, as the end of the transect approaches, the forward scanning distance becomes progressively shorter. Look over the same area more than once. Many alcids remain under water for a long time and may not be seen on the first, or even second, scan. Some birds may be located and identified by sound. In Alaskan waters, the most easily heard and recognized call is the contact note used by Marbled Murrelets. In general, it is more important to detect birds and accurately enumerate them than it is to identify them. For example, it is far more important count all murres than to spend excessive amounts of time trying to identify the birds to species.

Concentrate on the actual counting zone and do not spend much time scanning outside of that area. Uncommon sightings and flocks observed outside of the counting zone should be recorded, but they should not be actively sought, as this may result in birds being missed within the count zone. Perception of the width of the transect narrows with distance, so that it does not appear to be as wide at 1,000 m as it does at 100 m; take this into account when deciding which birds should or should not be recorded as within the transect zone. One often has to wait until a bird is directly abeam of the ship to decide if they are within the transect zone. Record all marine mammals sighted and flocks greater that 1,000 birds sighted,

Table 1. Number of seconds[a] required for ship to cover specific distances at selected speeds.

Speed (Knots)	Distance Traveled			
	200 m	300 m	500 m	1,000 m
6.0	64	96	160	320
6.5	59	89	148	295
7.0	55	82	137	274
7.5	51	77	128	256
8.0	48	72	120	240
8.5	45	68	113	226
9.0	43	64	107	213
9.5	40	61	101	202
10.0	38	58	96	192
10.5	37	55	91	183
11.0	35	52	87	175
11.5	33	50	83	167
12.0	32	48	80	160
12.5	31	46	77	154
13.0	30	44	74	148
13.5	28	43	71	142
14.0	27	41	69	137
14.5	26	40	66	132
15.0	26	38	64	128
15.5	25	37	62	124
16.0	24	36	60	120
16.5	23	35	58	116

[a] $\frac{1.92 \text{ x distance (m)}}{\text{speed (knots)}}$ = seconds

whether they are within the counting zone or outside. In the case of large flocks over large areas try to make one estimate of total flock size even if it may extend for several miles.

The width and length of the transect define a rectangle that is the count zone of the transect (Figure 2). Theoretically, we are trying to obtain an instantaneous count of birds within that rectangle. In practice, birds that enter the count zone from behind the ship during the transect are not counted, while those that enter or leave in front of the ship are counted. Large numbers of traveling birds (birds flying through the area while moving directly between two distant points) present a special problem. If the observer counted all the individuals flying through the counting zone, density indices would not only be greatly exaggerated, but would reflect birds using the air corridor over the water rather than the water. To reduce this particular bias, we have a special method of counting traveling birds.

When there are traveling birds passing through the area, each individual is not recorded. Instead, we make periodic instantaneous counts of traveling birds within the count zone. The number of such counts depends on the size of the instant count zone (the maximum distance at which all birds can be detected) and the speed of the ship (Table 2). For example, during a 10-minute transect at a speed of 10.0 knots, the ship would cover a total distance of 3,087 m. For large flying birds, we might take three instantaneous counts each covering an area extending about 1,000 m ahead of the ship and 300 m to one side. One count would be taken at the start of the transect, one at 200 seconds (ca. 3.3 minutes) into the transect and one at 400 seconds (ca. 6.6 minutes) into the transect. The three counts added together would be our estimate of the number of flying birds in the entire transect at any one time. Value judgements as to distance, and whether to include this or that bird, become easier and more trustworthy with experience. For smaller flying birds, such as storm-petrels, a counting zone of 300-500 m is usually more appropriate. Instantaneous counts to 300 m ahead of a ship moving at 10.0 knots would be taken at 0.97 minute intervals (1.6 minute intervals for a count zone of 500 m). If birds are sitting on the water or there are other indicators of position, instantaneous counts can be judged by these objects rather than by the time and speed of the ship. The distance from the observer to the end of the transect, at various ship speeds, can be obtained from Table 2.

A situation that needs special treatment is that of a large flock of birds being deflected in front of the ship, for example, 10,000 Short-tailed Shearwaters, all in one flock, streaming along the side of the ship and then across the bow. The flock is continuously passing in front of the ship because it is being deflected forward. Such a flock should only be counted once, i.e., in the first instant count, and then ignored in all future counts.

Land birds and flocks of shorebirds that are obviously just passing over the area on migration or moving between two distant points are handled differently than marine birds. By using proper coding techniques (see data coding), these sightings can be included in the data base without influencing density indices.

Table 2. Meters traveled per minute at various speeds.

Speed	Elapsed Time In Minutes									
(knots)	1	2	3	4	5	6	7	8	9	10
6	185	370	556	741	926	1111	1296	1482	1667	1852
7	216	432	648	864	1080	1296	1512	1729	1945	2161
8	247	494	714	988	1285	1482	1729	1975	2222	2469
9	278	556	833	1111	1389	1667	1945	2222	2500	2778
10	309	617	926	1235	1543	1852	2161	2469	2778	3087
11	340	679	1019	1358	1698	2037	2377	2716	3056	3395
12	370	741	1111	1482	1652	2222	2593	2963	3334	3704
13	401	803	1204	1605	2006	2408	2609	3210	3611	4013
14	432	864	1296	1729	2161	2593	3025	3457	3889	4321
15	463	906	1389	1852	2315	2776	3241	3704	4167	4630
16	494	988	1482	1975	2469	2963	3457	3951	4445	4939

The estimation of numbers is a major source of bias in surveys. Before going into the field, practice estimating large numbers of objects such as beans on a table or birds in pictures (Arbib 1972). Most field observers estimate the number of birds in large flocks by counting in 10's or 100's. This requires the observer to maintain a good mental picture of what 10 or 100 birds looks like. Flocks in the distance usually appear to have fewer birds than is actually the case, because many will be hidden by other birds or by waves and swells; some birds in feeding flocks may even be sitting on the water or diving beneath it. Distant vision at sea may also be impaired by atmospheric conditions such as rising heat and mist, which tend to obscure birds. It is important not to become overwhelmed with large numbers of birds; continue to count numbers of birds rather than make guesses.

SUPPORT DATA

Before departure, observers should learn as much as possible about the activities and protocol of the ship. They should meet with the appropriate officers and crew to fully explain what research will be conducted and what help will be needed. Techniques should be explained, stressing the importance of the ship maintaining a constant speed and course during observation periods. It is very frustrating to have a ship change course or stop in the middle of a transect. Plan your observation periods ahead of time and try to stick to the plan. Let the officers and crew know when you will be making observations and have them inform you about projected maneuvers and course changes. You can leave a standing call to be notified when large bird concentrations are encountered, but use these times for general observations rather than transects. It is important that you conduct transects throughout the survey in accordance with your regular schedule. Do not add or delete transects just because you encounter exceptionally high or low bird densities. In planning your schedule do not try to cram as many observations into a day as possible. Remember that you have lots of paper work to do for each transect you take, and that you see fewer birds when you are tired. It is preferable to collect a few data of high quality than many data of only moderate quality. The two most important pieces of supporting data that must be obtained for each transect are the correct position and the speed made good.

Position. Do not just accept positions given by bridge personnel, especially if they are being read from a LORAN C or satellite navigation system--these systems can be inaccurate and may vary from minute to minute. If land can be detected on radar, it is best to get a position by measuring the distance from at least two, and preferably three, distinct landforms--the correct position is where the arcs of the distances cross each other. Try to plot the position immediately to be sure there are no errors, and record the depth from the chart. If the position matches an electronic system such as a LORAN C interpolator, it can be assumed that the electronic system is correct and positions can be taken from it for the next hour or two. The position should also be checked at least every two hours. If the ship is too far from land to obtain good distance readings from a radar, or only one distance is available, the position from the LORAN C can be checked by a combination of depths, LORAN C lines, and bearings to a land mass.

To interpolate between two good positions, divide the speed in knots by 60 and multiply by the minutes duration of the transect. This gives you the distance traveled on each transect. This distance can then be stepped off with dividers between the beginning and ending positions, and each new position can then be read from the chart. The positions should always be calculated as soon as possible after the observations. When obtaining positions from a chart, the depth should also be taken and compared with the depth obtained from the ships equipment. If the crew of the ship are not plotting positions on a nautical chart at least every two hours, do so yourself, and be sure a position is taken at every course change. Check all of your positions for a logical and consistent progression. Be sure to write all the particulars of the fix in the field notes of the data form.

Speed. The speed made good is the distance traveled over the ocean floor. Due to tides, or the action of currents, the speed made good may be different from the speed through the water. In most cases, the difference between the two speeds is negligable, but in some passes, water may flow at a rate of several knots. Birds are usually associated with the water column, thus moving with it, and speed through the water may give a more accurate representation of bird density than speed over the bottom. Many research ships are now equiped with water speed indicators and, in areas of fast moving currents, the speed through the water should be used. Speed is always taken in nautical miles per hour (knots). One knot is equal to 1.15 statute miles/hour or 1.852 km/hr. The speed made good can be calculated by obtaining two good positions (preferably at least a couple hours apart) and measuring the distance between the two points with a pair of dividers. Move to the left or right edge of the chart at the same latitude (the scale varies with latitude on a mercator projection) and measure the nautical miles on the latitude scale. One nautical mile is equal to one minute of latitude and one degree of latitude is equal to 60 nauical miles. The speed made good is obtained by dividing the nautical miles traveled by the elapsed time (espressed in tenths of hours).

Depth. Depths can be read directly from a fathometer by yourself or by a crew member. If positions are accurate and navigation charts are available of sufficient scale, depths can be determined from the chart. However, it is always best to use the fathometer. We often record the depths in fathoms below the field on the transect form and convert it to meters at a later time (1.83m = 1 fathom).

Temperature. Sea-surface temperature is obtained in various ways. The ideal method is a continuously recording thermo-salinograph, which records both temperature and salinity on graph paper. Most ships measure sea temperature at the water intake for cooling their engines. This is often a couple of meters below the surface, but mixing is generally sufficient to get reasonable readings. Large ships usually record this temperature each hour. Unfortunately, the reading may be done by several persons each day and often little care is taken when reading the thermometer. Ask to see where the temperature guage is located and impress on the engine room personnel the importance of consistent and accurate readings. The best method is to check the temperatures yourself at the beginning and end of each series of transects. A third method of obtaining water temperatures is with a rapidly adjusting thermometer placed near the bottom of a freshly obtained bucket of surface water. Be sure to take the sample on the side of the ship opposite the outlet for hot water from the engines. Occasional bucket temperatures should be taken to check on the more frequently obtained intake temperatures. A rapid change in temperature often indicates the crossing of a current boundary or upwelling where the numbers of birds and species composition will change. If a sudden change in species composition or abundance is noted, ask for a new temperature reading. Depth, temperature, and other environmental data are best taken at the mid-point of each transect, but it is often more convenient to obtain them at the beginning. In either case, be consistent throughout the survey.

Ice. The presence of ice is a very important environmental parameter which affects the density and distribution of birds at sea. Coverage and pattern are the most important features of ice both within and outside of the counting zone. The distance to the ice edge is also very important, especially out to 20 miles, and should be recorded whenever possible.

Miscellaneous. Seabirds may react to meteorological events (Manikowski 1971). Barometric pressure is a good indicator of this and should be recorded for each transect. Other weather features (wind, precipitation, sea state, etc.) are somewhat less important but should be recorded when possible.

SURVEY PROCEDURES

Make sure all necessary environmental data (depth, temperature, etc.) and locational data (positions, speed, etc.) will be available and that the bridge personnel know that you are beginning observations. Select the best point on the ship from which you can obtain an unobstructed view of the potential count zone. Set your watch to match your time with that of the ship. Obtain from the bridge the ship's approximate speed and direction. Determine how many instantaneous counts you will need to fill up the transect. Record all environmental parameters such as barometric pressure and sea state and determine what the observation conditions are. Spend several minutes studying the birds in the immediate vicinity of the ship, noting the general behavior of all birds within the area, and then record the maximum number of each ship-following species on the transect form. Bow riding porpoises are handled the same as shipfollowers. Begin the transect by making the first instantaneous count.

SUPPLEMENTAL TECHNIQUES

Skiff Counts. Transects can be conducted from skiffs. All birds are counted within a specified distance on both sides of the skiff, 50-75 m on each side is a fairly standard distance if sitting and 75-100 m if standing. The area covered by the survey is determined by the distance between a starting and ending position, rather than by speed and time. It is best to conduct transects between known points of land or buoys so that you can obtain accurate positions. Linear distance (in hundreds of meters) must be placed in columns 76-78 of the coding form.

Coastline Counts. Coastline surveys are best conducted from skiffs or small ships. The observer should stay as far offshore as possible, while still being able to detect and identify all birds on the water and roosting on shore. All birds are counted between the shore and the platform and from the platform to the limit of visibility on the other side of the platform. On this type of survey, birds associated with nests are recorded with a 4 in the Zone column, while birds on the water (or in the case of waterfowl roosting on shore) are recorded in the survey. Usually the width of the count area is about 75 m on each side, but it varies with conditions. Density estimates are impossible to construct, and the unit of analysis is birds per km of coastline. We recommend using distinct headlands, as the division between counts so that they are easily repeated and birds within a bay are more likely to be recorded in the subsequent counts. In our experience, birds tend to forage throughout a particular bay more often than they move between bays.

Ship-follower Counts. Ship-following birds are not included in density indices, but it is worthwhile to keep a continuous record of their turnover rate, especially when individual birds cannot be told apart. On every transect the observer records the largest number of each ship-following species seen at any one time. Turnover rates of individuals and indices of ship-follower abundance can then be derived. In addition, ship follower counts add to the observers awareness of what birds are in the area and how the birds are reacting to the ship. It also provides a perspective on whether to count birds approaching the ship and to interpret whether a sighting represents a new bird or one previously counted.

Station Counts. These counts are taken from a fixed point, usually from a ship stopped for oceanographic sampling or fishing. These counts are valuable for determining the numbers of birds which may be dependent on fishing vessels or vulnerable to pollution from ships. They also provide an excellent opportunity to obtain various ratios, e.g., color phases, age, sex, species, etc. The survey area is generally a circle with a 300m to 600 m radius and the observer at the center. All birds are counted within the count zone by making a circular sweep of the entire area as rapidly as is consistent with accurate detection and counting of birds within the area. Only one sweep is made per survey. The length of time the ship has been stationary should be recorded for each survey, because numbers of birds usually continue to build up for a long period after the ship has stopped. The best place to record this information, along with pertinent information on the ships activity, is in the field notes section of the data sheet. Whenever possible, these counts should be repeated every 30 or 60 minutes.

General Observations. Important incidental observations should be recorded and are maintained within the data base. Of particular importance is the location of feeding flocks, large assemblages, and rare species which would not otherwise be recorded. General observations are used: in cases where transects terminate before the designated time, where the ship makes large scale changes in course or speed during the transect, where other reasons invalidate the use of the observations to develope density indices, between standard transects, or in areas and time frames where transects were not planned.

RECORD KEEPING

Data Coding. Data collected during pelagic surveys are transcribed onto coding forms (Figure 3, Appendix 2) using special codes (Appendix 3). Data are then entered directly into the computer from the coding forms. These forms are usually filled in at the time of the observation, directly from binoculars to coding form. If it is impossible to record directly onto the form, tape recorders or water proof notebooks can be used, but data should then be transferred to the coding forms as soon as possible. Unless a second person is available to record the data, we recommend the use of a tape recorder, especially in areas where more than a few birds are sighted per transect, because birds may be missed each time one looks down to record a sighting. All marine mammal sightings in the transect zone and outside are recorded into the same format as bird sightings, except that the codes for BEHAVIOR are different. Coding forms constitute our major field record, and as such should be very legibly filled out in pencil, double checked for accuracy, and kept clean and in a safe place. Any pertinent observations that cannot be coded should be clearly printed in the space provided under FIELD NOTES. This should include documentation of all rare or unusual sightings. Figure 3 gives examples of proper entry of raw data onto the coding form.

Do not enter numbers into any field when the information is unknown or in doubt unless there is a specific code for unknown or doubtful. A zero usually means actual data. When a field (e.g., STATION, TRANSECT WIDTH, NUMBER OF BIRDS) is used, zeros should not be placed in the columns to the left of the first significant number or letter entered, i.e., zero fill to the right but not to the left. For example, in the STATION NUMBER field, transect number 1 should be entered as "--1", transect 10 as "-10", and transect 100 as "100". If there are no birds observed within the counting zone then the form is filled out with NONE or BIRD for the alpha identification code, a "0" in the number column, and a "0" in the zone column. Our data-entry program will automatically generate the taxonomic code when the proper species alpha code (APPENDIX 4) is entered. It is thus necessary to enter the taxonomic code on the data sheet only if an alpha code is not listed.

We have developed a number of analysis programs which require that certain coding fields be entered. These fields are listed and completely explained in Appendix 2. It is of vital importance that observers read Appendix 2 very carefully to clearly understand coding techniques. The codes form and placement of many of the fields were originally developed by a number of researchers within the OSCEAP program. We have tried to keep this format as similar as possible to the National Oceanographic Data Center's (NODC) file type "033" format and codes.

3

HEADER

FILE TYPE	FILE IDENTIFIER	STAT NO	STAT TYPE
1 2 3	4 5 6 7 8 9	11 12 13	14 15
033	F85100	27	69

U.S. FISH & WILDLIFE SERVICE

PELAGIC SEABIRD PROJECT

PAGE 157
OBSERVER('S) Gould
TRANSCRIBER Forsell

LOCATION

RT	START LAT DEG	MIN	S	H	START LONG DEG	MIN	S	H	DATE - TIME YR	MON	DAY	HR	MIN	END LAT DEG	MIN	S	H	END LONG DEG	MIN	S	H	ELAP TIME	± TIME ZONE	SPEED KNOTS	COURSE	HT. METERS	SUB	REGION	DIST KM	OC	HAB 1	HAB 2	TRANS WIDTH 10's M
10	16 17	18 19	20	22	23 24 25	26 27	28	30	31 32	33 34	35 36	37 38	39 40	41 42	43 44	45	47	48 49 50	51 52	53	55	56 57	58 59 60	61 62 63	64 65	66 67 68	69	70 71	72 73 74	75	76	77	78 79 80
1	52	27	5	N	173	29	0	W	85	10	24	18	00									10	+11	10	27	8		22		5			30

ENVIRONMENT

RT	DEPTH METERS	±	SURFACE WATER TEMP	SAL	DIST TO LAND NM	ICE	BAROMETRIC PRESSURE MB	±	WIND KN	SEA	SWELL HT M	WEATHER	ICE IN TRANS C	T	F	R	TH	M	OUT C	T	TIDE
10	16 17 18 19	23	24 25 26	27 28 29	31 32 33 34	35	39 40 41 42 43	44	47 48	49	52 53 54	55 56	59	60	61	62	63	64	65	66	69
2	785	+	9.5	32.0	18.7		1006.2	+	11	2	1.5	03									

429F

DATA

RT	COMMON NAME	TAXONOMIC CODE	AGE	SEX	CP	GROUP SIZE	NUMBER	FLT DIR	LNK	BEHAVIOR	OZ	HAB	SEQ
10	63 64 65 66	18–27	32	33	34		37 38 39 40 41	48 49	53	56 57	60	76 77	79 80
5	COMU					1,2,4,6	13			01	0		1
5	BLKI		P			1	1	24		20	0		2
5	STSH					50,20,18,	88			01	0		3
5	STSH					1000	1000			01	2		4
5	TUPU					13	13		1	70	0		5
5	BLKI					18	18		1	71	0		6
5	COMU					4	4		1	70	0		7
5	NOFU				6	1,1,10	12			29	0		8
5	COMU		P			1,	1		2	01	0		9
5	COMU		A		0	1,	1		2	01	0		10
5	WAAL					1,	1			29	0		11
5	STSH					150550,	99111		1	[illegible]	2		12
5	[illegible]						50001		1	[illegible]	2		13
5	S1SH						550		1	[illegible]	[illegible]		14

FIELD NOTES

Loran C 16010
49571

Seguam I 32.2 NM
Cape Shaw-Atka I 20 NM
Cape Idalug-Amlia Is 19.7 NM

- Feeding Flock

Young bird 3/4 size of adult

- Wandering Albatross sighting questionable Gould couldn't provide ~~adeq~~ adequate discription - Hahal

ACKNOWLEDGEMENTS

The basis for all pelagic surveys of marine birds was established many years ago by the efforts of such pioneers as Hilary B. Moore, Robert C. Murphy, W. R. P. Bourne, and a great many other biologists and laymen. We began in early 1975 with the conception and definition of a project in Alaska by Calvin J. Lensink. This project has evolved and refinements have been made up to the present time with the help of more people then we can either remember or enumerate. To all who helped: Thank You.

There are a few people to whom we extend special thanks. Robert Day, Craig Harrison, Wayne Hoffman, Calvin Lensink, Hal Petersen, and Gerald Sanger all contributed extensive amounts of time and intelligence to the development of these techniques.

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LITERATURE CITED

Ainley, D. G., and S. S. Jacobs. 1981. Sea-bird affinities for ocean and ice boundaries in the Antaractic. Deep-Sea Res. 28A:1173-1185.

Arbib, R. 1972. On the art of estimating numbers. American Birds 26:706-712; 814.

Bailey, R. S. 1968. The pelagic distribution of sea-birds in the western Indian Ocean. Ibis 110:493-519.

Bailey, R. S., and W. R. P. Bourne. 1972. Notes on sea-birds 36, counting birds at sea. Ardea 60:124-127.

Briggs, K. T., W. B. Tyler and D. B. Lewis. 1985. Aerial surveys for seabirds: Methodological experiments. J. Wildl. Manage. 49(2):412-417.

Brown, R. G. B., F. Cooke, P. K. Kinnear, and E. L. Mills. 1975. Summer seabird distributions in Drake Passage, the Chilean Fjords and off southern South America. Ibis 117:339-356.

Forsell, D. J., and P. J. Gould. 1981. Distribution and abundance of marine birds and mammals wintering in the Kodiak area of Alaska. U. S. Fish and Wildlife service, Office of Biological Services, Washington, D. C. FWS/OBS81/13.

Gould, P. J. 1974. Introduction, pp. 1-5. In Warren B. King, Ed., Pelagic Studies of Seabirds in the Central and Eastern Pacific Ocean. Smithsonian Contributions to Zoology 158. Washington, D. C.

Gould, P. J. 1983. Seabirds between Alaska and Hawaii. Condor 85:286-291.

Gould, P. J., D. J. Forsell, and C. J. Lensink. 1982. Pelagic distribution and abundance of seabirds in the Gulf of Alaska and eastern Bering Sea. FWS/OBS-82/48. U. S. Fish & Wildlife Service, Biological Services Program, Anchorage, AK.

Harrison, C. S. 1982. Spring distribution and abundance of marine birds in the Gulf of Alaska. Condor 84:245-254.

Heinemann, D. 1981. A range finder for pelagic bird censusing. J. Wildl. Mgmt. 42:489-493.

Hunt, G. L., Jr., P. J. Gould, D. J. Forsell, and H. Petersen, Jr. 1981. Pelagic distribution of marine birds in the eastern Bering Sea, pp. 689-718. In (D. W. Hood and J. A. Calder, Eds.) The Eastern Bering Sea Shelf: Oceanography and Resources. Off. Mar. Pollut. Assess., NOAA Seattle, WA.

Jespersen, P. 1930. Ornithological observations in the north Atlantic Ocean. The Danish "Dana" Expeditions 1920-22 in the North Atlantic and the Gulf of Panama. Oceanographical Reports edited by the "Dana" Committee No. 7, Copenhagen.

Kessel, B. 1979. Avian habitat classification for Alaska. Murrelet 60:86-94.

King, J. E., and R. L. Pyle. 1957. Observations on sea birds in the tropical Pacific. Condor 59:27-39.

King, J. G., G. E. Marshal, J. H. Branson, F. H. Fay, and W. Allen. 1974. Alaskan pelagic bird observations and a data bank proposal. Unpublished Report, U. S. Fish & Wildlife Service, Juneau, AK.

King, W. B. 1970. The trade wind zone oceanography piolet study Part VII: observations of sea birds March 1964 to June 1965. Special Scientific Report-Fisheries No. 586. U. S. Fish and Wildlife Service and Bureau of Commercial Fisheries.

King, W. B., G. E. Watson, and P. J. Gould. 1967. An application of automatic data processing to the study of seabirds, I: Numerical Coding. Proc. U. S. Nat. Mus. 123(3609):1-29.

Kuroda, N. 1960. Analysis of sea bird distribution in the northwest Pacific Ocean. Pacific Science 14:55-67.

Manikowski, S. 1971. The influence of meteoroloical factors on the behavior of sea birds. Acta Zoologica Cracoviensia XVI(13):582-673.

Powers, K. D. 1982. A comparison of two methods of counting birds at sea. J. Field Ornith. 53:209-222.

Savard, J. L. 1979. Marine birds of Dixon Entrance Hectate Strait and Chatham Sound, B. C. during fall 1977 and Winter 1978. Canidan Wildlife Service 104pp.

Shuntov, V. P. 1972. Marine birds and the biological structure of the ocean. Pac. Res. Instit. Manage. Oceanogr. (TINRO), Far-Eastern Publishers, Vladivostok. (Transl. farom Russian, Agence Tunisienne de Public-Relations for U.S. Dept. Int., Bur. Sport Fish. and Wildl., and Natl. Sci. Found. 1974).

Siniff, D. B., D. R. Cline and A. W. Erickson. 1970. Population densities of seals in the Weddel Sea, Antarctica, in 1968. Antarctic Ecology 1:377-394.

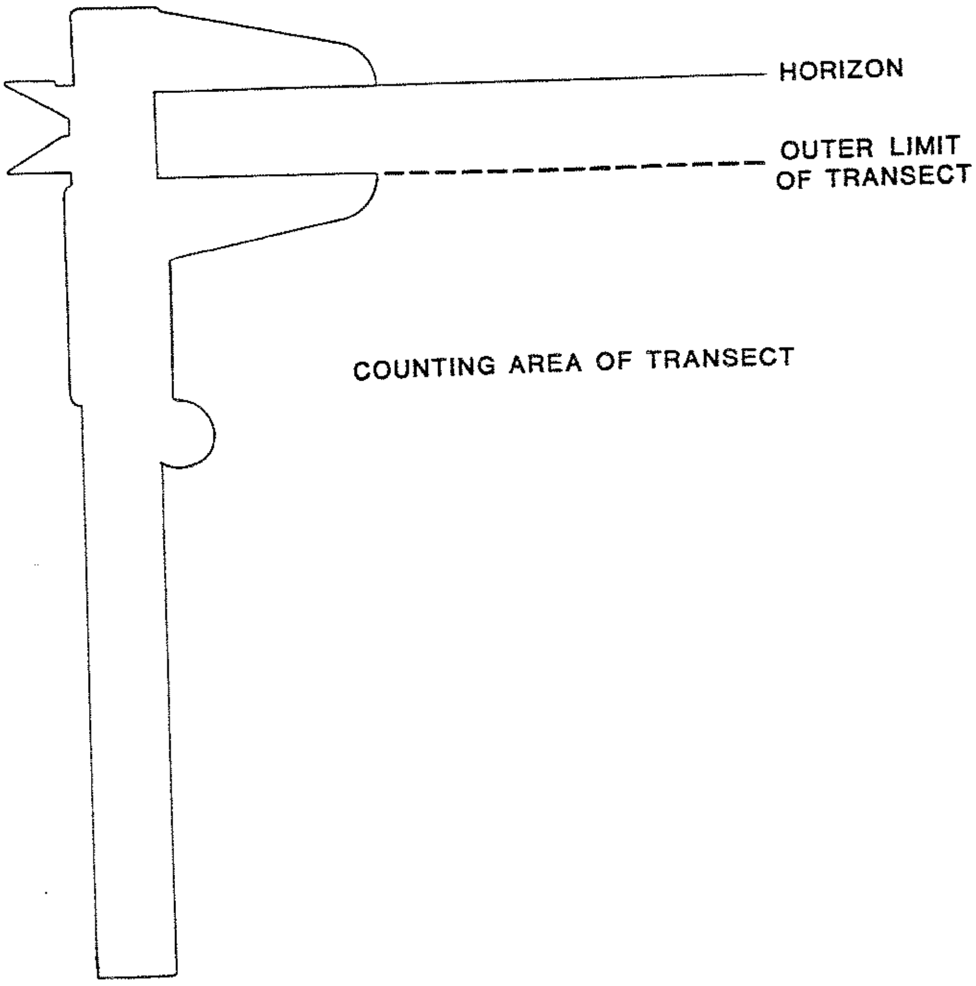
Tasker, M. L., P. Hope Jones, T. Dixon, and B. F. Blake. 1984. Counting seabirds at sea from ships: A review of methods employed and a suggestion for a standardized approach. Auk 101:567-577.

Thorsteinson, L. (Ed.). 1984. Proceedings of a synthesis meeting: the north Aleutian shelf environment and possible consequences of planned offshore oil and gas development; Anchorage, Alaska, March 9-11, 1982. U. S. Dept. Commerce, NOAA, Office of Marine Pollution Assessment, Juneau, AK.

Wiens, J. A., D. Heinemann, and W. Hoffman. 1978. Community structure, distribution and interrelationships of marine birds in the Gulf of Alaska, pp. 1-178. In Environmental Assessment of the Alaskan Continental Shelf, Final Reports of Principal Investigators, Vol. 3. NOAA, Environ. Res. Lab., Boulder, CO.

Wynne-Edwards, V. C. 1935. On the habits and distribution of birds on the North Atlantic. Proc. Boston Soc. Nat. Hist. 40:233-346.

Appendix 1a. Example of calipers used as range finder. The caliper set according to the values obtained from Table 1 for the appropriate distance from the eye and the height above the water. The upper jaw is placed on the horizon and the lower jaw denotes the outer limit of the transect. This device is only valid if the horizon is in clear view and undistorted by rough seas. It's use is only recomended at heights greater than 6 m and when there is minimal up and down movement of the ship.



Appendix 1b. Setting of rangefinder in mm for various distances from eye to rangefinder and heights above water for a 300 m transect zone.

Distance From Eye To Rangefinder (centimeters)	Height Above Water (meters)									
	6	7	8	9	10	11	12	13	14	15
46	8.9	10.4	11.9	13.4	15.0	16.4	18.0	19.5	21.0	22.5
48	9.3	10.9	12.4	14.0	15.6	17.2	18.8	20.3	21.9	23.5
50	9.7	11.3	13.0	14.6	16.3	17.9	19.5	21.2	22.8	24.5
52	10.1	11.8	13.5	15.2	16.9	18.6	20.3	22.0	23.8	25.5
54	10.5	12.2	14.0	15.8	17.6	19.3	21.1	22.9	24.7	26.5
56	10.8	12.7	14.5	16.4	18.2	20.0	21.9	23.7	25.6	27.4
58	11.2	13.1	15.0	16.9	18.9	20.8	22.7	24.6	26.5	28.4
60	11.6	13.6	15.5	17.5	19.5	21.5	23.5	25.4	27.4	29.4
62	12.0	14.0	16.1	18.1	20.2	22.2	24.2	26.3	28.4	30.4
64	12.4	14.5	16.6	18.7	20.8	22.9	25.0	27.1	29.2	31.4
66	12.8	14.9	17.1	19.3	21.5	23.6	25.8	28.0	30.2	32.3
68	13.2	15.4	17.6	19.9	22.1	24.3	26.6	28.8	31.1	33.3
70	13.6	15.9	18.2	20.2	22.8	25.1	27.4	29.7	32.0	34.3
72	13.9	16.3	18.7	21.0	23.4	25.8	28.1	30.5	32.9	35.3
74	14.3	16.8	19.2	21.6	24.1	26.5	28.9	31.4	33.8	36.3
76	14.7	17.2	19.7	22.2	24.7	27.2	29.7	32.2	34.7	37.2

$Ci = \frac{b\ h\ (v - d)}{(h^2 + vd)}$, where: $v = 3{,}838\ (h^{1/2})$

c = setting in mm

b = arm length in mm

d = width of transect in m

h = height of eye above water in ft

Appendix 2. Explanation and format of information fields for digital data.

HEADER CARD

FILE TYPE (1-3): Always 033. Signifies marine bird transects in NODC Data Base

FIELD OPERATION NUMBER (4-9): This number identifies an individual field operation. It is assigned by the Alaska Office of Fish and Wildlife Research, 1011 E. Tudor Rd., Anchorage, Alaska, 99503.

STATION NUMBER (11-13): A sequential number beginning with 1 for each field operation; this number cannot be duplicated during any one field operation.

STATION TYPE (14-15): Codes 1 and 2 (Appendix 3). Column 14 indicates the type of platform, and column 15 indicates the type of survey.

RECORD TYPE (10): Distinguishes information pertaining to location, environment and ice conditions, and census data.

RECORD TYPE 1: LOCATION DATA

START LATITUDE (16-22) and START LONGITUDE (23-30): Position of platform at the start of observations in degrees (DEG), minutes (MIN), seconds (S), and hemisphere (H). Seconds may be recorded as tens of seconds. Alpha codes (N, S, E, and W) are used for hemisphere.

DATE (31-36) and TIME (37-40): Year, month, day, and time at start of observations (use local time and a 24 hour clock).

END LATITUDE (41-47) and END LONGITUDE (48-55): Position of platform at end of observations in degrees (DEG), minutes (MIN), seconds (S), and hemisphere (H). Seconds may be recorded as tens of seconds. Alpha codes (N, S, E, and W) are used for hemisphere. This field is needed for aerial surveys, coastline counts, skiff counts, or if observations last 30 minutes or longer.

ELAPSED TIME (56-57): Length of survey, in minutes.

TIME ZONE (58-60): Time zone of time entered on transect form relative to Greenwich Mean Time. The first digit is a "+" or "-".

SPEED (61-63): Platform speed made good, in whole knots.

COURSE (64-65): Platform course made good, in tens of degrees (based on true north).

HEIGHT (66-68): Height of observer's eye above water, in meters.

SUBSTRATE (69): Codes assigned by the observer for a specific project. This code has only been used in shoreline surveys up to this time. Codes from 0 to 9 can be assigned and any set of numbers chosen for analysis.

WIND SPEED (47-48): Speed of wind, in knots.

SEA STATE (49): See Code 5, Appendix 3.

SWELL (52): Height, in 1/10 of meters.

WEATHER (55-56): See Code 6, Appendix 3.

ICE IN TRANSECT (59-65) and ICE OUT OF TRANSECT (67 & 68):

Coverage (59 & 65): See Code 7, Appendix 3.
Type (60 & 66): See Code 8, Appendix 3.
Form (61): See Code 9, Appendix 3.
Relief (62): See Code 10, Appendix 3.
Thickness (63): See Code 11, Appendix 3.
Stage of Melt (64): See Code 12, Appendix 3.

TIDE (75): See Code 13, Appendix 3.

RECORD TYPE 5: OBSERVATION DATA

COMMON NAME (----): See Appendix 4. These alpha codes are entered during the transect. The taxonomic code (18-29) is inserted by the computer from these codes; thus it is important to use the alpha codes listed in Appendix 4. Generally, we use the first two letters of each common name (e.g., Common Murre = COMU). If one of the names is hyphenated we use the first letter of each name (e.g., Red-legged Kittiwake = RLKI). UN is used for unknowns (e.g., unidentified gull = UNGU, unidentified large alcid = UNLA).

TAXONOMIC CODE (18-29): It is *not* necessary to complete these columns if the proper alpha code is used. We use the National Oceanographic Data Center (NODC) codes, which are based on five taxonomic groupings each with with two digits. For example a common murre is represented by 9129010301 where 91 = class (Aves); 29 = Order or suborder (Chardriformes); 01 = family (Alcidae); 03 = genus (*Uria*) 01 = species epithet (*aalgae*). This code system enables us to analyze our data at various taxonomic levels. A list of common taxonomic codes is presented in Appendix 4.

AGE (31): See Code 14, Appendix 3.

SEX (33): See Code 15, Appendix 3.

COLOR PHASE or PLUMAGE (34): See Code 16, Appendix 3.

GROUP SIZE (------): This area of the form is to accumulate individual sightings of a particular species with the same behaviors, flight directions, sex, age, color phase, and plumage attributes. The total number is then put in the Number Field (37-41). Each sighting may be used for analysis by hand of group sizes thus each individual or group acting as a unit should be entered as a separate number in group size. This field is especially helpful when recording data directly on the data forms.

REGION OR SURVEY AREA (70-71): Codes assigned by the observer for a specific cruise or project. Regions from 00 to 99 can be assigned and any set of numbers chosen for analysis.

DISTANCE (72-74): Distance traveled between start and end of transect, to the nearest 1/10 kilometer. This field must be completed for coastline surveys and transects conducted from skiffs where speeds may vary. This field may be completed for transects where area calculations of greater precision are needed than will be obtained from speed in whole knots or where transects are of a fixed distance reguardless of time or speed.

OBSERVATION CONDITIONS (75): See code 3, Appendix 3. A subjective evaluation of observation conditions, on a scale of 1 to 7, with 7 being ideal. Observation conditions take into account All factors that may affect the ability of the observer to detect all the birds in the counting zone including sea state, visibility, wind, light, observer's position on the ship, quality of binoculars, and the condition and attentiveness of the observer. An observation condition of 7 would mean all birds, even at 300m, are probably detected and identified. Under conditions of 1 or 2 enough birds are missed that we do not use the observations for density estimates, but occurrence and large flocks are still important.

HABITAT I (76): Codes assigned by the observer for a specific cruise or project. Codes from 0 to 9 can be assigned and any combination of numbers chosen for analysis.

HABITAT II (77): Codes assigned by the observer for a specific cruise or project. Codes from 0 to 9 can be assigned and any combination of numbers chosen for analysis.

TRANSECT WIDTH (78-80): Width of counting zone in tens of meters (e.g., 300 m zone is recorded as "30".

RECORD TYPE 2: ENVIRONMENTAL DATA

DEPTH (16-19): Depth of water column, in whole meters at start of observations. If the transect begins or ends at shore enter 1 meter. One fathom is equal to 1.83 meters. This field should compleated for all transects.

SURFACE TEMPERATURE (23-26): Surface temperature of water to nearest 1/10 degree Centigrade. Column 23 indicates positive or negative degrees (if left blank positive values are assumed).

SURFACE SALINITY (27-29): Surface salinity, to nearest 1/10 parts per thousand.

DISTANCE TO LAND (31-34): Distance to nearest land, in 1/10 nautical miles.

DISTANCE TO ICE EDGE (35-38): See Code 4, Appendix 3. Distance to nearest ice edge, in nautical miles.

BAROMETRIC PRESSURE (40-44): Barometric pressure, to nearest 1/10 millibar. Column 44 uses + for rising, 0 for steady, and - for falling.

NUMBER (37-41): Number of birds recorded within the parameters defined by Transect Width and Zone columns.

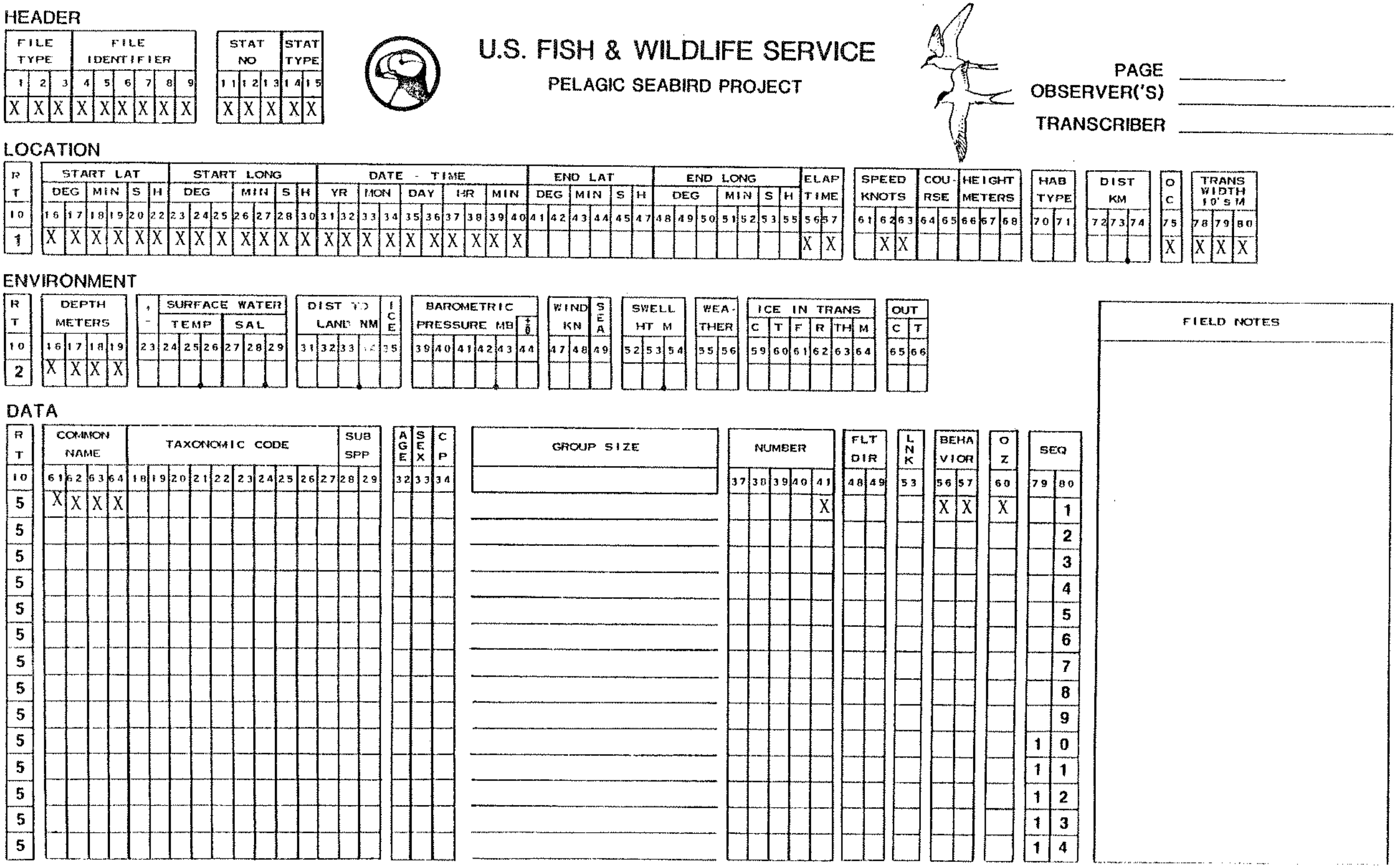
FLIGHT DIRECTION (48-49): Direction of birds flight in tens of degrees (based on true north)

LINKAGE (51-53): These columns are used to unite two or more records into a single sighting or to link two or more related sightings. For example, if 150,000 birds were observed in one flock then two cards each of 75,000 would be needed. Each of these cards would have "1" in the linkage column. Another example would be if a feeding flock of more than one species were observed, all of the species sighted would be linked with a common number. Successive associations that occur on one transect are consecutively numbered.

BEHAVIOR (56-57): See Codes 17 and 18, Appendix 3.

ZONE (60): See Code 18, Appendix 3. This field increases the versatility of the transect form by allowing us to record other significant observations such as large flocks, rare birds, feeding associations, dead birds, and ship followers into the data base. For example, if a flock is partially within the transect, those birds within the counting zone are recorded with a "0" in the zone column while the rest would be recorded with a "2" in the zone column. Incidently, the sightings would be linked with a common number in the linkage column. A "0" must be recorded for all sightings to be used for calculating density indicies.

SEQUENCE NUMBER (78-80): These numbers make each record unique and are entered by the computer.



U.S. FISH & WILDLIFE SERVICE

PELAGIC SEABIRD PROJECT

PAGE ______

OBSERVER('S) ______

TRANSCRIBER ______

HEADER

FILE TYPE			FILE IDENTIFIER						STAT NO			STAT TYPE	
1	2	3	4	5	6	7	8	9	11	12	13	14	15
X	X	X	X	X	X	X	X	X	X	X	X	X	X

LOCATION

R T	START LAT						START LONG							DATE - TIME									
	DEG		MIN		S	H	DEG			MIN		S	H	YR		MON		DAY		HR		MIN	
10	16	17	18	19	20	22	23	24	25	26	27	28	30	31	32	33	34	35	36	37	38	39	40
1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

R T	END LAT						END LONG							ELAP TIME		SPEED KNOTS			COURSE		HEIGHT METERS			HAB TYPE		DIST KM			O C	TRANS WIDTH 10'S M		
	DEG		MIN		S	H	DEG			MIN		S	H																			
10	41	42	43	44	45	47	48	49	50	51	52	53	55	56	57	61	62	63	64	65	66	67	68	70	71	72	73	74	75	78	79	80
1														X	X		X	X											X	X	X	X

ENVIRONMENT

R T	DEPTH METERS				±	SURFACE WATER						DIST TO LAND NM				ICE
						TEMP			SAL							
10	16	17	18	19	23	24	25	26	27	28	29	31	32	33	34	35
2	X	X	X	X												

R T	BAROMETRIC PRESSURE MB					±	WIND KN		SEA	SWELL HT M			WEATHER		ICE IN TRANS						OUT	
															C	T	F	R	TH	M	C	T
10	39	40	41	42	43	44	47	48	49	52	53	54	55	56	59	60	61	62	63	64	65	66
2																						

DATA

R T	COMMON NAME				TAXONOMIC CODE										SUB SPP		AGE	SEX	CP
10	61	62	63	64	18	19	20	21	22	23	24	25	26	27	28	29	32	33	34
5	X	X	X	X															
5																			
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R T	GROUP SIZE	NUMBER					FLT DIR		LNK	BEHAVIOR		OZ	SEQ	
10		37	38	39	40	41	48	49	53	56	57	60	79	80
5						X				X	X	X		1
5														2
5														3
5														4
5														5
5														6
5														7
5														8
5														9
5													1	0
5													1	1
5													1	2
5													1	3
5													1	4

FIELD NOTES

Figure 3. Coding form with an "X" in fields required for a valid at sea transect.

Appendix 3. Codes for digital data.

Code 1. Platform Type (14)

1 = Centerview Aircraft (P2V, Partanavi, etc.)
2 = Twin engine sideview aircraft (Goose or Otter)
3 = Single-engine aircraft
4 = Helicopter
5 = Fixed at-sea platform
6 = Ship greater than 100 feet
7 = Ship less than 100 feet
8 = Small boat with outboard motor
9 = Other (on foot)

Code 2. Survey Type (15)

1 = General observations:	These are records of large flocks, rare or unusual sightings, transects that cannot be used to derive density indices, or any record that will not fit another format.
2 = Inland waterway count:	These surveys are conducted in lakes, lagoons, or rivers
3 = Bay or fjord transect:	The criteria for a transect are a visibility of at least 1,000 m and a moving platform with a constant speed and direction. A bay or fjord transect is one made within well defined headlands.
4 = Coastline count:	A transect conducted within 100 m of the shore and follows the contour of the shoreline, rather than a straight line.
5 = Ship-follower count:	A count of only ship-followers.
7 = Station count:	The criteria for a station count are that the platform is stationary and that all birds are counted in a 360 degree circle from the platform.
9 = Oceanic transect:	The criteria for a transect are a visibility of at least 1,000 m and a moving platform with a constant speed and direction. An oceanic-transect is conducted outside of well defined headlands.

Code 3. Observation Conditions (75)

1 = Bad (general observations only)
2 = Poor (no quanitative analysis)
3 = Fair
4 = Average
5 = Good
6 = Excellent
7 = Optimum

Code 4. Distance to Ice Edge (35)

0 = Up to one nautical mile
1 = 1.1-2 nautical miles
2 = 2.1-4 nautical miles
3 = 4.1-6 nautical miles
4 = 6.1-8 nautical miles
5 = 8.1-12 nautical miles
6 = 12.1-16 nautical miles
7 = 16.1-20 nautical miles
8 = greater than 20 nautical miles

Code 5. Sea State (49)

0 = Calm
1 = Rippled (0.01-0.25 feet)
2 = Wavelet (0.26-2.0 feet)
3 = Slight (2-4 feet)
4 = Moderate (4-8 feet)
5 = Rough (8-13 feet)
6 = Very rough (13-20 feet)
7 = High (20-30-feet)
8 = Over 30 feet

Code 6. Weather (55-56)

00 = Clear to partly cloudy; (0-50% cloud cover.
03 = Cloudy to overcast; 51-100% cloud cover.
41 = Fog (patchy)
43 = Fog (solid)
68 = Rain
71 = Snow
87 = Hail

Code 7. Ice Coverage (59 & 67)

0 = less than one octa (1 octa = 1/8)
1 = 1 octa
2 = 2 octas
3 = 3 octas
4 = 4 octas
5 = 5 octas
6 = 6 octas
7 = 7 octas
8 = 8 octas (with openings)
9 = 8 octas (no openings)

Code 8. Ice Type (60 & 68)

1 = New ice
2 = Fast ice
3 = Pack or drift ice
4 = Packed slush or sludge
5 = Shore ice
6 = Heavy fast ice
7 = Heavy pack or drift ice
8 = Hummocked ice
9 = Icebergs

Code 9. Ice Form (61)

1 = Ice of land origin
2 = Pancake ice
3 = Brash ice or ice cakes
4 = Small ice floes (car sized)
5 = Medium ice floes (house sized)
6 = Large ice floes (acre sized)
7 = Vast ice floes (football field sized)
8 = Giant ice floes (big)
9 = Fast ice

Code 10. Ice Relief (62)

0 = Level ice
1 = Rafted ice
2 = Finger rafted ice
3 = Hummocks
4 = New ridges
5 = Weathered ridges
6 = Very weathered ridges
7 = Aged ridges
8 = Consolidated ridges
9 = Standing flow

Code 11. Ice Thickness (63)

0 = less than 5 cm
1 = 5-9 cm
2 = 10-19 cm
3 = 20-29 cm
4 = 30-39 cm
5 = 40-59 cm
6 = 60-89 cm
7 = 90-149 cm
8 = 150-249 cm
9 = 250+ cm

Code 12. Ice Melting Stage (64)

0 = No melt
1 = Discolored ice
2 = Flooded ice
3 = Few puddles
4 = Many puddles
5 = Puddles with few thaw holes
6 = Puddles with many thaw holes
7 = Thaw holes, no puddles
8 = Rotten ice
9 = Refrozen or refreezing puddles

Code 13. TIDE (69):

1 = High
2 = 3/4 outgoing
3 = 1/2 outgoing
4 = 1/4 outgoing
5 = Low
6 = 1/4 incomming
7 = 1/2 incomming
8 = 3/4 incomming

Code 14. Age (32)

P = Pullus (flightless young)
J = Hatching year (hatching date to spring molt; a bird capable of sustained flight.
I = Immature
S = Subadult (last year prior to adult plumage).
A = Adult

Code 15. Sex (33)

1 = Male
2 = Female

Code 16. Color Phase and Molt (34)

1 = Double light; (all white bird)
2 = Light (Fulmar = bird with some dark feathers on upper wing, rest white)
3 = Between light and intermediate
4 = Intermediate (Fulmar = dark wings, some darking of belly)
5 = Between intermediate and dark
6 = Dark (Fulmar = bird completely dark except white spots on wings
7 = Double dark (very dark bird)
8 = Breeding plumage
9 = Winter plumage
0 = Molt evident

Code 17. Bird Behavior (56-57)

00 = Undetermined
01 = Sitting on water
09 = Sitting on water next to ice
10 = Sitting on floating object
14 = Sitting on ice
15 = Sitting on land
20 = Flying in direct and consistent heading
29 = Flying, height variable
31 = Flying, circling ship
32 = Flying, following ship
34 = Flying, being pirated
35 = Flying, milling or circling (foraging)
48 = Flying, meandering
61 = Feeding at or near surface, while flying (dipping or pattering)
65 = Feeding at surface, (scavenging)
66 = Feeding at or near surface not diving or flying (surface seizing)
70 = Feeding below surface (pursuit diving)
71 = Feeding below surface (plunge diving)
82 = Feeding above surface (pirating)
90 = Courtship display
98 = Dead bird

Code 18. Mammal Behavior (56-57)

00 = Undetermined
01 = Leaping
02 = Feeding
03 = Mother w/young
04 = Synchronous diving
05 = Bow riding
06 = Porpoising
07 = Hauled out
08 = Sleeping
09 = Avoidance
14 = Curious/following
15 = Cetacea/pinniped association
16 = Pinniped/bird association
17 = Cetacea/bird association
18 = Breeding/copulation
19 = Moribund/dead

Code 19. Zone (60):

0 = Bird within counting zone (= transect width)
1 = Ship follower
2 = Bird seen outside of counting zone during a transect
3 = Bird seen within 1/2 hour before or after a transect or survey
4 = Bird on or over land during a transect or survey
5 = Bird on or over land before or after a transect or survey
6 = Bird found on ship before or after a transect or survey
7 = Dead on water

Appendix 4. Taxonomic Code List

ALPHA CODE	NUMERIC CODE	COMMON NAME
NONE	91	No Birds
BIRD	91	Bird
UNBI	91	Unidentified Bird
UNLO	91070101	Unidentified Loon
UNSL	91070101	Unidentified Small Loon
UNLL	91070101	Unidentified Large Loon
COLO	9107010101	Common Loon
YBLO	9107010102	Yellow-billed Loon
ARLO	9107010103	Arctic Loon
RTLO	9107010104	Red-throated Loon
UNGR	91080101	Unidentified Grebe
RNGR	9108010101	Red-necked Grebe
HOGR	9108010102	Horned Grebe
UALB	910901	Unidentified Albatross
STAL	9109010101	Short-tailed Albatross
BFAL	9109010102	Black-footed Albatross
LAAL	9109010103	Laysan Albatross
WAAL	9109010104	Wandering Albatross
UNPR	910902	Unidentified Procellariid
NOFU	9109020201	Northern Fulmar
UNDS	91090204	Unidentified Dark Shearwater
UNSH	91090204	Unidentified Shearwater
UNLS	910902040	Unidentified Light Shearwater *
PISH	9109020402	Pink-footed Shearwater
FFSH	9109020403	Flesh-footed Shearwater
PFSH	9109020403	Pale-footed Shearwater
WTSH	9109020405	Wedge-tailed Shearwater
NZSH	9109020406	New Zealand Shearwater
BUSH	9109020406	Buller's Shearwater
SOSH	9109020407	Sooty Shearwater
STSH	9109020408	Short-tailed Shearwater
NESH	9109020409	Newell's Shearwater
SKSH	9109020413	Streaked Shearwater
CHSH	9109020414	Christmas Shearwater
UNPT	91090205	Unidentified Pterodroma
MOPE	9109020503	Mottled Petrel
COPE	9109020505	Cook's Petrel
PHPE	9109020508	Phoenix Petrel
HAPE	9109020509	Hawaiian Petrel
BOPE	9109020510	Bonin Petrel
BWPE	9109020511	Black-Winged Petrel
SOPE	9109020512	Solander's Petrel
STPE	9109020513	Stejneger's Petrel
PYPE	9109020514	Pycroft's Petrel
GOPE	9109020515	Gould's Petrel
BUPE	9109020601	Bulwer's Petrel

UNSP	910903	Unidentified Storm-Petrel
UDSP	910903020	Unidentified Dark Storm-Petrel - LESP or HASP *
FTSP	9109030201	Fork-tailed Storm-Petrel
LESP	9109030202	Leach's Storm-Petrel
ASSP	9109030203	Ashy Storm-Petrel
BRSP	9109030205	Band-Rumped Storm-Petrel
BLSP	9109030207	Black Storm-Petrel
SOSP	9109030208	Sooty Storm-Petrel
SWSP	9109030209	Swinhoe's Storm-Petrel
WTTR	9110010102	White-Tailed Tropicbird
RTTR	9110010103	Red-Tailed Tropicbird
WHPE	9110020101	White Pelican
BRPE	9110020102	Brown Pelican
MABO	9110030101	Masked Booby
BFBO	9110030102	Blue-Footed Booby
BRBO	9110030103	Brown Booby
RFBO	9110030104	Red-Footed Booby
UNCO	91100401	Unidentified Cormorant
DCCO	9110040102	Double-crested Cormorant
BRCO	9110040104	Brandt's Cormorant
PECO	9110040105	Pelagic Cormorant
RFCO	9110040106	Red-faced Cormorant
MAFB	9110060101	Magnificent Frigatebird
GRFB	9110060102	Great Frigatebird
LEFB	9110060103	Lesser Frigatebird
UNDU	911201	Unidentified Duck, Goose, or Swan
WHSW	9112010201	Whooper Swan
TUSW	9112010202	Tundra Swan
TRSW	9112010203	Trumpeter Swan
CAGO	9112010301	Canada Goose
BRAN	9112010303	Brant
EMGO	9112010401	Emperor Goose
WFGO	9112010501	White-fronted Goose
SNGO	9112010601	Snow Goose
UNPD	91120109	Unidentified Puddle Duck
MALL	9112010901	Mallard
NOPI	9112010907	Northern Pintail
GWTE	9112010910	Green-winged Teal
AMWI	9112010916	American Wigeon
NOSH	9112010917	Northern Shoveler
LESC	9112011105	Lesser Scaup
GRSC	9112011106	Greater Scaup
UNGO	91120112	Unidentified Goldeneye
COGO	9112011201	Common Goldeneye
BAGO	9112011202	Barrow's Goldeneye
BUHE	9112011203	Bufflehead
OLSQ	9112011301	Oldsquaw
HADU	9112011401	Harlequin Duck
UNEI	91120117	Unidentified Eider
STEI	9112011601	Steller's Eider
COEI	9112011701	Common Eider
KIEI	9112011702	King Eider

SPEI	9112011703	Spectacled Eider
UNSC	91120118	Unidentified Scoter
WWSC	9112011802	White-winged Scoter
SUSC	9112011803	Surf Scoter
BLSC	9112011804	Black Scoter
UNME	91120121	Unidentified Merganser
COMF	9112012101	Common Merganser
RBME	9112012102	Red-breasted Merganser
BAEA	9113021002	Bald Eagle
GYFA	9113040201	Gyrfalcon
PEFA	9113040203	Peregrine Falcon
UNSB	9127	Unidentified Shorebird
AMOY	9127030102	American Oystercatcher
BLOY	9127030103	Black Oystercatcher
CHAR	912704	Charadriidae
UNCH	912704	Unidentified Charadriid
SEPL	9127040202	Semipalmated Plover
SNPL	9127040204	Snowy Plover
GOPL	9127040402	Golden Plover
UNSC	912705	Unidentified Scolopacid
UNTU	91270501	Unidentified Turnstone
RUTU	9127050101	Ruddy Turnstone
BLTU	9127050102	Black Turnstone
CALI	91270512	*Calidris* species
ROSP	9127051204	Rock Sandpiper
STSA	9127051205	Sharp-Tailed Sandpiper
PESA	9127051206	Pectoral Sandpiper
DUNL	9127051214	Dunlin
WESA	9127051217	Western Sandpiper
SURF	9127051301	Surfbird
UNPH	912707	Unidentified Phalarope
REPH	9127070101	Red Phalarope
RNPH	9127070301	Red-necked Phalarope
UNJA	91280101	Unidentified Jaeger
POJA	9128010101	Pomarine Jaeger
PAJA	9128010102	Parasitic Jaeger
LTJA	9128010103	Long-tailed Jaeger
GRSK	9128010201	Great Skua
SPSK	9128010202	South Polar Skua
UNGU	91280201	Unidentified Gull
UNLG	912802010	Unidentified Large Gull *
GLGU	9128020101	Glaucous Gull
GWGU	9128020103	Glaucous-winged Gull
SBGU	9128020105	Slaty-backed Gull
WEGU	9128020106	Western Gull
HEGU	9128020108	Herring Gull
GHGU	912802010899	Glaucous-Winged X Herring Gull Hybrid *
CAGU	9128020110	California Gull
RBGU	9128020111	Ring-billed Gull
BTGU	9128020112	Black-tailed Gull
MEGU	9128020113	Mew Gull

BOGU	9128020117	Bonaparte's Gull
HRGU	9128020119	Heerman's Gull
IVGU	9128020201	Ivory Gull
UNKI	91280203	Unidentified Kittiwake
BLKI	9128020301	Black-legged Kittiwake
RLKI	9128020302	Red-legged Kittiwake
ROGU	9128020401	Ross's Gull
SAGU	9128020501	Sabine's Gull
UNTE	91280207	Unidentified Tern
FOTE	9128020702	Forster's Tern
COTE	9128020703	Common Tern
ARTE	9128020704	Arctic Tern
ALTE	9128020706	Aleutian Tern
GBTE	9128020710	Gray-backed Tern *
SOTE	9128020707	Sooty Tern
LETE	9128020709	Least Tern
ELTE	9128020802	Elegant Tern
CATE	9128020901	Caspian Tern
BRNO	9128021101	Brown Noddy
BLNO	9128021102	Black Noddy *
WHTE	9128021201	White Tern
BLSK	9128030101	Black Skimmer
UNAL	912901	Unidentified Alcid
UNSA	9129010	Unidentified Small Alcid *
SDAL	9129010	Small Dark Alcid *
UNLA	91290100	Unidentified Large Alcid *
UNML	912901000	Unidentified Murrelet *
UNMU	91290103	Unidentified Murre
COMU	9129010301	Common Murre
TBMU	9129010302	Thick-billed Murre
DOVE	9129010401	Dovekie
UNGI	91290105	Unidentified Guillemot
BLGU	9129010501	Black Guillemot
PIGU	9129010502	Pigeon Guillemot
BRMU	91290106	Brachyramphus Murrelet
MAMU	9129010601	Marbled Murrelet
KIMU	9129010602	Kittlitz's Murrelet
XAMU	9129010701	Xantus' Murrelet
CRMU	9129010702	Craveri's Murrelet
ANMU	9129010801	Ancient Murrelet
JAMU	9129010802	Japanese Murrelet
CAAU	9129010901	Cassin's Auklet
USDA	9129011	Unidentified Small Dark Auklet - CAAU, WHAU, LEAU, CRAU*
PAAU	9129011001	Parakeet Auklet
UNAE	91290111	Unidentified Aethia auklet
CRAU	9129011101	Crested Auklet
LEAU	9129011102	Least Auklet
WHAU	9129011103	Whiskered Auklet
RHAU	9129011201	Rhinoceros Auklet
UNPU	91290113	Unidentified Puffin
HOPU	9129011302	Horned Puffin
TUPU	9129011401	Tufted Puffin *

BEKI	9147010101	Belted Kingfisher
UNPA	9158	Unidentified Passeriform
TRSW	9158020301	Tree Swallow
BASW	9158020401	Bank Swallow
BOWA	9158090101	Bohemian Waxwing
UNWA	915829	Unidentified Warbler
TOWA	9158290807	Townsend's Warbler
UNFR	915833	Unidentified Fringillidae
PISI	9158331901	Pine Siskin
OLSP	9158332101	Olive Sparrow
SASP	91583325	Savannah Sparrow
FOSP	9158333501	Fox Sparrow
LALO	9158333702	Lapland Longspur
CORA	9158450701	Common Raven
NWCR	9158450704	Northwestern Crow
DUWA	9158470103	Dusky Warbler
UNPO	921802	Unidentified Porpoise
CODO	9218020601	Common Dolphin
NRWD	9218021001	Northern Right Whale Dolphin
RIDO	9218021101	Risso's Dolphin
KIWH	9218021601	Killer Whale
HAPO	9218021801	Harbor Porpoise
DAPO	9218022001	Dall's Porpoise
SPWH	9218040102	Sperm Whale
UBKW	921805	Unidentified Beaked Whale *
UNBW	9219	Unidentified Baleen Whale *
GRWH	9219010101	Gray Whale
MIWH	9219020101	Minke Whale
SEWH	9219020103	Sei Whale
FIWH	9219020104	Fin Whale
HBWH	9219020201	Humpback Whale
BOWH	9219030102	Bowhead Whale
POBE	9220010101	Polar Bear
SEOT	9220020101	Sea Otter
UNPI	92210	Unidentified Seal or Sea Lion = pinniped
CASL	9221010301	California Sea Lion
STSL	9221010501	Steller's Sea Lion
NOFS	9221010601	Northern Fur Seal
WALR	9221020101	Walrus
UNSE	922103	Unidentified Seal
LASE	9221030101	Largha Seal
RISE	9221030102	Ringed Seal
RBSE	9221030106	Ribbon Seal
HASE	9221030107	Harbor Seal
BESE	9221030301	Bearded Seal
ELSE	9221031002	Elephant Seal

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* Codes are not standard NODC.