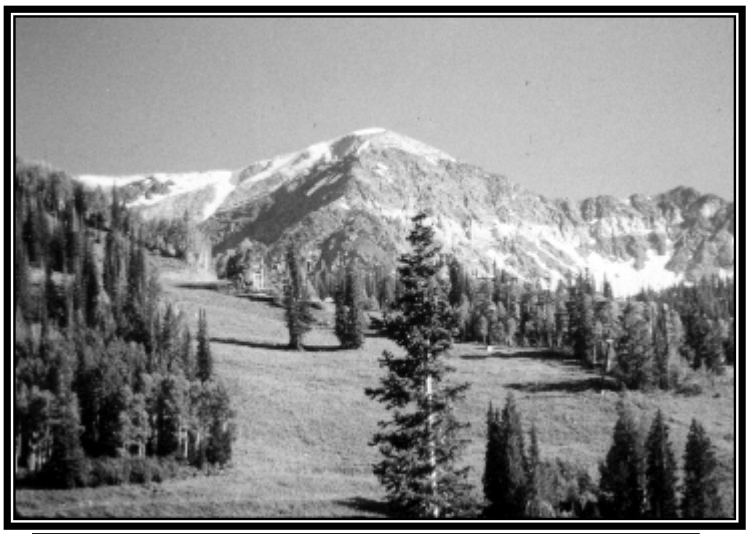
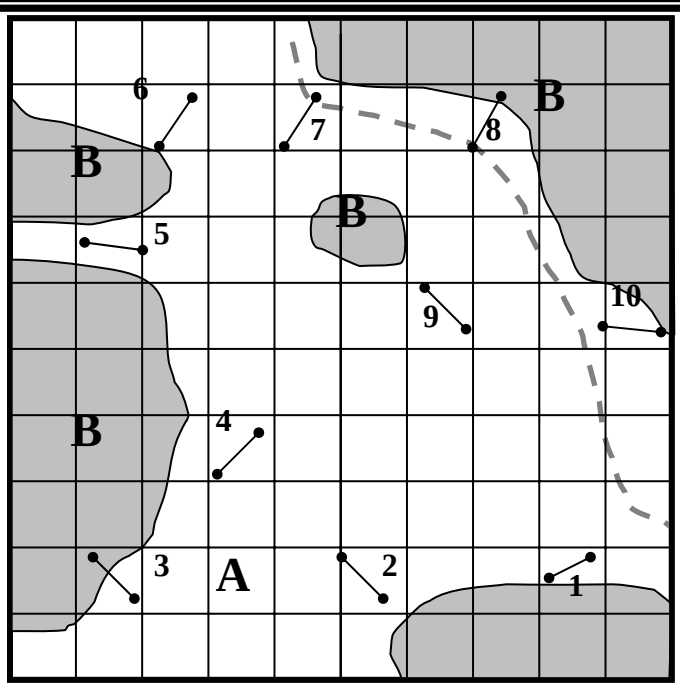
Monitoring Avian Productivity and Survivorship (MAPS)

Habitat Structure Assessment (HSA) Protocol:

describing vertical and horizontal spatial habitat patterns at MAPS stations





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Introduction

The Monitoring Avian Productivity and Survivorship (MAPS) program is focused on monitoring avian demographic parameters and relating their spatial and temporal variation to landscape-scale ecological and environmental data. For this purpose we utilize geographic information systems (GIS), remote sensing of habitat types, and existing vegetation maps from various sources, at a variety of spatial resolutions (e.g., from 1km to 30m cells). Unfortunately, these kinds of spatial data are often very coarse. For instance, the 30m resolution Multi-Resolution Land Cover (MRLC) database can provide general categories of habitat type (e.g., deciduous forest, shrubland) but no information regarding the specific plant communities and vertical structure of the vegetation associated with the habitat types.

The horizontal pattern, vertical structure, and type of the vegetation within a MAPS station can affect the number and diversity of breeding birds present, as well as the efficiency with which birds can be monitored by mist-netting. Many ecological studies show that habitat structure is an important factor for predicting avian diversity and abundance. It has been shown, in general, that spatial habitat patterns and vertical habitat structure are good predictors of the presence and relative demographic success of component species in avian communities. Furthermore, changes in the vegetation at a station may cause changes in the breeding bird community or affect how attractive the site is to dispersing birds. For all these reasons, the Habitat Structure Assessment (HSA) protocol is designed to describe the type and distribution of the vegetation at each monitoring station in each year.

The types of vegetation at a MAPS station are classified using plant alliances described by a federally accepted standard (National Vegetation Classification Standard, 1997,Vegetation Subcommittee, Federal Geographic Data Committee). The HSA protocol provides an on-ground assessment of the vegetation type and structure (similar to, but more detailed than the NVCS data collection form), which can be compared to remotely sensed spatial vegetation data. In addition, the protocol provides us with fine-resolution data, such as the vertical structure of a forested patch or the presence of small ponds, that may be undetectable by remote methods.

MAPS banding data can be combined with remotely sensed datasets, habitat structure assessment data, breeding status lists (BSL), breeding/overwintering range data, and various weather and other environmental data to tackle some aspects of avian population conservation. Analyses of these data will help guide efforts towards the ultimate goal of providing management solutions to the problems of declining avian populations, and to make these solutions available to a variety of land stewards. The success of this approach will depend in large measure upon the participation of station operators in applying the HSA protocol.

Habitat Structure Assessment (HSA)

The Habitat Structure Assessment protocol is designed to describe the horizontal and vertical structure of the habitat type(s) present at a MAPS station. The goal is to describe the arrangement and coverage of up to five (but normally two) discrete and recognizable habitat types at your station and, within each of those habitat types, to describe the arrangement and coverage of component vertical layers. We provide a pictorial guide to a number of spatial arrangements of patches to help you in this task and a blank grid map to help you map and classify the main habitat types within your station.

The methods outlined in these instructions are designed to provide useful information with a minimum of effort. Please keep in mind that the purposes of these maps and descriptions are:

a) to provide a general classification and characterization of the habitat of the study area to allow for broad comparisons and groupings among stations;
b) to provide a method for monitoring major changes in the vegetation that occur as a result of natural successional change, new management practices (logging, grazing, development), or the occurrence of major "catastrophes" such as fire or flood; and
c) to provide a relatively rapid assessment of the habitat structure and spatial patterns of vegetation.

Once the results of these assessments are analyzed, we will be able to group stations in terms of features to which a chosen target species may respond. Then we can investigate in more detail, using remotely sensed imagery and ground-truthed vegetation maps, the landscape-level (within 10km of station) spatial habitat patterns associated with stations belonging to those groups. In this way we hope to identify the landscape patterns associated with high population levels and high productivity indices of target species. We can then suggest management actions to achieve similar spatial habitat patterns in areas with lower population levels and lower productivity. This combination of monitoring population demographics, ecosystem modeling, population modeling, and management action provides the basis for an adaptive management approach at the community or ecosystem level.

Beginning in the 2002 field season, Habitat Structure Assessments no longer need to be conducted yearly. Instead, complete **Habitat Structure Assessments should be conducted every five years, unless the habitat at the station has undergone a major change** (e.g., fire, hurricane, logging, construction, brush-clearing, etc.). We do ask that contributors take a copy of their station map and competed HSA forms into the field each year at the appropriate time (see below) and verify that the information is correct, and has not significantly changed. These vegetation assessments, both complete HSA's and yearly verifications, should be made during the **fourth period of recommended operation** (usually the time of maximum canopy and shrub cover).

It may be helpful to follow the step-by-step approach to preparing your station map and habitat description(s) as outlined on the following pages.

A Step-by-Step Approach to the MAPS Habitat Structure Assessment

Step1: Prepare a station map. The station map should depict the locations of your nets and the major physical features of the study area. A typical MAPS station consists of about ten 12-m mist nets dispersed rather uniformly over an 8-hectare (20-acre) core area. Plot the exact location, orientation, and designation (net number) of each of your nets in the central portion of a copy of the

24 x 24 cell grid map (Form H0: MAPS Station Map) provided in the HSA protocol. The scale of each cell on this map should normally be 30m on a side. If your station is very long you might need to increase the size of a map cell from the standard 30m to perhaps 40m. If your station is very small (because you have your nets spaced closely together; see below), you might need to decrease the size of a map cell down to 20m. Be sure to indicate the scale on your station map by using the scale bar provided. In addition, plot also the exact locations of all the important natural and human-made physical features such as lakes, ponds, streams, ditches, roads, trails, buildings, and other structures. Be sure also to indicate magnetic north on your map. If possible, obtain an aerial photograph or GIS output of the site, use it to help locate the nets and other physical features on your station map, and submit it to IBP *in addition* to the station map. It is important to mark clearly the **exact location and orientation** of each net on the station map. This will assure that the location and orientation of individual nets will remain consistent if the personnel operating a station changes from year to year.

Step 2: Identify the boundary of your station and draw it on the station map. The boundary of a MAPS station is defined to include all areas that lie within 100m of the outermost nets. Remember, 100m is equal to over eight standard (12m) net lengths; you may be surprised at how much area this encompasses! On the map, however, 100m is a distance equivalent to three and one-third cells on the 30m grid (see heavy dashed line on Figure 1). The station boundary itself can be determined by first drawing a circle with radius equal to 100m centered at the outermost end of each net. This should produce a set of overlapping circles. Then connect the outermost points of the outermost circles with a smooth, straight or slightly outwardly convex line. This will give you the boundaries of your station. If you have nets that are more than 200m removed from all other nets (producing non-overlapping circles), a corridor about 100m wide between these nets and encompassing the route traveled to reach them should be included within the station boundary. In this way, all stations will be single units regardless of layout of their nets.

Note that, in general, this procedure will create an approximately 20 hectare (50 acre) station if ten nets are dispersed over an 8-hectare (20-acre) core area. In the ideal case, the periphery of the 8-hectare core area would approximately be a square 280m on a side or a 160m radius circle, while the boundary of the 20-hectare station would approximately be a square 450m on a side or a 250m radius circle. When plotted on the 30m grid map, such stations will encompass about 225 squares (a grid of 15 x 15 cells for a square station). The shape of your station, however, may not be a square or a circle. Nets, for example, might be located along a riparian corridor, within and around a montane meadow, or around part of an ox-bow lake. To allow you to map variously shaped stations, Form H0 depicts a 24 x 24 cell grid. In general you should try to include between about 200 and 250 cells in your station. Even if your station is long and narrow, it should be drawn at least eight squares wide; a map using a grid of 9 x 24 cells might be ideal for such a case. Figure 1 presents an example of a completed station map. This example is based on an actual map submitted to us by Ken Heselton. Note that the nets are clustered somewhat more closely than normal for a typical MAPS station and, as a result, the total area of the station is only about 13 hectares (rather than 20 hectares).

Step 3: Define and delineate the habitats within the station. Habitat definitions should be based primarily on vegetation type and structure, and hydrology. Generally, anything smaller than about one ha (about 2.5 acres) in area - roughly equivalent to about ten or eleven 30m grid cells - should not be considered a separate habitat. Water features, such as lakes or rivers, should ***not*** be considered a separate habitat, regardless of size. Consider also the bird communities present in deciding whether to define and delineate separate habitats; different habitats should be reflected in some way in the

bird communities they support. However, do not define your habitats too narrowly; if you wind up with more than five, you must reconsider your definitions. ***Typically, stations have one, two or three habitat types; only rarely are there more, so do not feel obliged to recognize five habitat types.***

Provide a concise name for each habitat type you identify within your station. In addition, use the National Vegetation Classification Standard (1997) provided in Appendices 1-6 to identify each habitat type to the **ALLIANCE** level (see below under 'National Vegetation Classification Standard Alliance'). Please ensure that **no two habitat types present within your station have the same alliance code.** For example, consider a station in the Sierra Nevada that encompasses coniferous forest surrounding a meadow featuring extensive willow thickets that in total cover just over one hectare and a patch of black oak woodland covering two hectares.

The forested area may contain two major tree species with some sort of delineation; let us say *Pinus contorta* (lodgepole pine) forest is more dominant near the edge of the montane meadow but *Abies magnifica* (red fir) forest dominates the interior. In this case, the coniferous forest should be treated as two habitat types since *Pinus contorta* forest and *Abies magnifica* forest can be separated spatially and represent different alliances (from Appendix 4, page 1: IA8Nc26 and IA8Nb4, respectively). The *Quercus Kelloggii* (black oak) woodland is obviously a separate alliance (from Appendix 4, page 2: IIC2Na4).

Similarly, you would classify the *Salix sp*. (willow) thickets (from Appendix 4, page 5: IIIB2Nd30 - 39) as a different habitat type from the montane meadow. It is also possible that in managed areas there will be distinct patches of, for instance, woodland or forest almost entirely dominated by different tree species; we suggest that these be treated as separate habitats. A mature *Pinus contorta* plantation would be defined by the NVCS as alliance IA8Cc26 (the C for "Planted/Cultivated" replaces the N for "Natural/Semi-natural", see above and Appendix 2). These patches of different forest will likely be of different ages and under different management regimes with respect to fire and harvesting. This will affect the structure and composition of the plant communities that occur within them and, in turn, will affect the composition of the avian communities that utilize them.

Clearly indicate the habitat delineations on your station map by drawing solid lines around them and shading the area if necessary. However, do not let your shading mask the clarity of net locations and other physical features. Indicate on your map the date that you finalized your habitat delineation.

Step 4: Establish the dominance class of the main habitat types within your station. Identify up to five main habitat types and determine their relative dominance within your station boundaries:

Dominant - the dominant habitat is the one occupying the largest proportion of the station (regardless of where nets are located). This should correspond to Habitat Code A.

Subdominant - the subdominant habitat is the one occupying the second largest proportion of the station. This should correspond to Habitat Code B.

Minor - minor habitats are those occupying proportions of the station less than or equal to that of the subdominant habitat. You may define up to three minor habitat types corresponding to Habitat Codes C, D and E. Remember that minor habitats must cover at least one hectare

(or at least 5% of the area of a typical station). In general, defining a second or third minor habitat type is rarely required. Aim for the fewest number that well represents the station.

Example: Your station consists of a small meadow dotted with willow thickets surrounded by forest, and a small stream runs through the middle of the meadow. In this case ***forest*** is the dominant habitat (A), even if all the nets are within the meadow. ***Grassland/meadow*** represents the subdominant habitat (B), and ***willow shrubland*** represents a minor habitat (C). Similarly, a narrow, wooded draw in a prairie would be a subdominant ***woodland*** habitat; the prairie is the dominant ***grassland/meadow*** habitat, even if all the nets are in the draw. Marshy areas also may represent a minor type. If you have difficulty, IBP can help you identify the number of habitat types that exist in your station and help you classify them according to NVCS codes (see front cover for contact information).

Step 5: Complete the MAPS Habitat description forms A single form is provided which you will need to photocopy (or download from our website) for each dominant, subdominant and minor habitat type that constitutes the station (Form H1: Habitat Assessment Form). The form allows you to indicate the dominance level of the habitat under consideration. For each habitat type, consider only the portion of that habitat that falls within the station boundaries. It is very important that you complete the habitat description every year, at the appropriate time, and without reference to previous descriptions. We feel strongly that two people should complete the assessment independently of one another, then compare results and reach a consensus opinion to minimize observer bias. ***We request that only the set of forms representing the consensus opinion be submitted to IBP: one HSA Form H1 for each habitat type present at the station and a completed station map (HSA Form H0).***

The following descriptions will help you understand how to fill in the various boxes on the Habitat Assessment Form. First we deal with the categories of cover and pattern which are used to describe the horizontal arrangement of different habitat types within your station. Similarly 'cover' and 'pattern' are also applied to the different vegetative layers within the habitat type. 'Cover' and 'pattern' are also used to describe the different elements of the ground cover layer (i.e. live vegetation, dead vegetation and non-vegetative features such as rock, sand or pavement). This provides us with a five tier hierarchical system; a station has habitat types, each of which has a number of vegetative layers. The ground cover layer itself has three components, of which the non-vegetative component can itself have four types of non-vegetative features.

Cover and Pattern

The two variables, **cover** classification and the **pattern** of that coverage, represent the most important information regarding the spatial characteristics of a habitat type, or of a vegetative layer (e.g., upperstory) or non-vegetative feature (e.g., standing water) within a single habitat type (e.g., forest).
It is essential to understand these concepts as they are used consistently throughout this protocol!

Cover: When describing habitat types, **cover** applies to the percentage of the station that is covered by that particular habitat type. When **cover** is used to describe upperstory, midstory, and understory vegetative layers, it is defined as the sum of the areas delimited by the vertical projections of plant perimeters onto the ground and not to light passing through the foliage of a single tree, shrub or fern. Consider any area inside the "drip-line" of the individual plant or tree as fully covered. Any overlap of cover between neighboring individual plants or trees is only considered once. ***In this case a completely closed canopy forest with overlapping crowns can only total 100% cover.*** In the case of ground cover, **cover** is defined as the percentage of the ground covered by live vegetation, dead

vegetation or the various non-vegetative features. Note that the sum of these percentages must add up to 100% ground cover.

Coding of cover relies upon eleven categories representative of easily estimable ranges of percentage cover (Table 1). These categories represent the midpoints of the NVCS ranges of percentage cover. The eleven categories range from <5 to 10, 20, …, 90, >95, each representing the percentage midpoint of the percentage ranges indicated in Table 1. **Do not enter the raw percentages except when considering the total coverage of a habitat type or ground cover within a habitat type**.

Table 1**.** Cover categories based on the midpoints of the corresponding ranges of percent cover. These are also listed on the Habitat Assessment Form (Form H1) and in Figure 3.

Category	Range
<5	0-5%
10	5-15%
20	15-25%
30	25-35%

Category	Range
40	35-45%
50	45-55%
60	55-65%
70	65-75%

Category	Range
80	75-85%
90	85-95%
>95	>95%

It is worth noting that when considering just two habitat types the cover category codes must be paired (<5 with >95; 10 with 90; 20 with 80; 30 with 70; 40 with 60; and 50 with 50).

Pattern: The variable **pattern** describes the overall horizontal spatial pattern of the target habitat type or vegetative layer. Basically, for a given percentage habitat cover, different spatial arrangements alter the perimeter:area ratio which reflects how ‘simple’, ’clumped’ or ‘dispersed’ the pattern of a habitat or vegetative layer can be. For instance, nine cells arranged as a square patch of 3x3 cells represent maximum clumping and has a perimeter:area ratio of 12/9 = 1.33. Alternatively, nine cells arranged in 1x9 strip is less clumped with a ratio of 20/9=2.22, whereas nine isolated cells are maximally dispersed with a perimeter:area ratio of 36/9 = 4.

A high perimeter:area ratio with high cover defines a well connected landscape in which it is easy for an individual to move across the landscape through a single habitat type without crossing patches of other kinds of habitat – this is termed “connectivity”. Conversely, the same percentage cover with a low perimeter:area ratio infers a clumped distribution that would provide a minimum patch size for a species to establish a territory or build a nest. Perimeter:area ratio is just one of a larger set of *landscape metrics* we can use to identify predictors of presence/absence of a species, species richness, or even species-specific productivity.

The spatial pattern of the main habitat types present at your station can be identified by matching the pattern you see in the field with one of twelve patterns illustrated in the Spatial Pattern Chart (Figure 2). These patterns are carefully chosen to represent commonly seen arrangements of natural and managed habitat patches with particular characteristics of “cover”, “clumpiness” and “dispersion”.

We have split these patterns into three main categories. Pattern codes 1-6 represent simple large patches with high clumping; codes 7-10 represent clumped distributions of smaller patches with increasing total coverage, and codes 11 and 12 represent highly dispersed habitat patches of increasing total coverage. Pattern code 8 differs from pattern code 9 in that the clumps tend to be disconnected rather than connected; in fact, pattern code 8 is the inverse of pattern code 9. Compare these patterns with the descriptions and examples of each pattern code provided below in Table 2.

Remember black cells represent the target habitat and white cells represent the non-target habitat. With only two habitat types present, pattern codes may also be paired (i.e. #2 with #3, #4 with itself, #5 with #6, #7 with #10, #8 with #9 and #11 with #12).

Table 2. Habitat Pattern categories with descriptions and examples which correspond to the graphical examples given in the Spatial Pattern Chart (Figure 2).

Code	Pattern	Description	Examples
1	SIMPLE - COMPLETE	Total cover of a single habitat type (or vegetative layer).	Prairie grassland, dense forest or any extensive habitat type.
2	SIMPLE SURROUNDED	A large patch of a single habitat type surrounded by another habitat type.	A meadow in a forest or a willow thicket within a meadow.
3	SIMPLE - SURROUNDING	A habitat type surrounding a patch of another type.	The forest around a meadow or the meadow around a thicket.
4	SIMPLE - EDGE	A habitat type with an edge that crosses the station.	The edge of a large forest where it meets grassland.
5	SIMPLE - DIVIDED	Large patch of habitat divided by another habitat type - extensive edge.	Woodland, forest or meadow either side of a riparian corridor.
6	SIMPLE - DIVIDING	Narrow habitat patch with extensive edge dividing another habitat type.	Riparian corridors, or bare ridgelines dividing forest habitat.
7	CLUMPED - LOW COVER	Varying sized habitat clumps spread through the landscape.	Clumps of shrubs invading a grassland prairie.
8	CLUMPED – MEDIUM COVER	A few large clumps of habitat type within the landscape.	Shrubby thickets in a divided watercourse.
9	CLUMPED – MEDIUM COVER	Narrow patches of intricately connected habitat with extensive edge.	Divided watercourse and associated wet meadows.
10	CLUMPED – HIGH COVER	Patches of non-habitat are spread throughout the landscape.	Nearly closed-canopy forest with clumped areas of selective logging.
11	DISPERSED – LOW COVER	Small isolated patches of habitat dotting the landscape.	Shrubs in a grassland or saplings in forest gaps caused by treefall.
12	DISPERSED – HIGH COVER	Almost homogenous patch but with well spaced small holes in it.	Mature forest with small clearings caused by treefall.

Cover and Pattern Exercise

The spatial pattern and coverage of a habitat type may preferentially attract certain species to breed there and also determines how individual organisms of many species move through the landscape. Some bird species that prefer to disperse through, or nest in, forest or woodland may avoid crossing large open spaces – they require their preferred habitat to be well connected. Some of these species may have a minimum forest patch size requirement and will not establish a breeding territory within a smaller sized patch. Other species may prefer the edge habitats provided by a more fragmented forest landscape (or grassland or shrub).

Consider Patterns #2, #7 and #11 in the context of a species that requires at least eight squares of contiguous habitat in order to establish a territory. All these patterns have 25% coverage of black squares but #2 is a single patch certainly big enough to hold three territories, and #7 is six variously sized patches – only one of which is big enough to hold a territory. On the other hand #11 consists of

many small highly dispersed patches, none of which could hold a territory for a species that requires eight contiguous squares of black habitat.

There is a clear shift in the level of connectivity between 40% and 60% coverage that depends upon

how the clumped the patches are. For instance, pattern #8 is 50% covered with three discrete large patches of black habitat that are clearly not well connected. On the other hand Pattern #9 (the inverse of Pattern #8) also has 50% cover of black habitat through which an individual could move without crossing white habitat. The patterns presented in Figure 2 are typical of the kinds of pattern we see in nature. They are intended to be a guide to categorizing the spatial patterns of the main habitats within the boundaries of your station(s).

Consider Figure 3. This is an aerial photograph of part of the Fort Leonard Wood military installation in Missouri. The contrast has been adjusted to discriminate patches of forest and woodland (dark areas) from the shrub/grassland areas (light areas) and the roads and trails (white). If you have an aerial photograph (or GIS based habitat map) of your station(s) then it may help you determine the spatial pattern and coverage of habitat types and possibly the vegetative layers within them. Otherwise, try to picture the layout of your station from above – a bird's eye view if you like. Seven squares labeled A-G depict areas that represent boundaries of potential MAPS stations, each containing different patterns and cover categories of the two contrasting habitat types. The dark areas represent woodland and the light areas represent shrub/grassland habitat. We will refer to them as "tree habitat" and "scrub habitat." These patterns are intended to exemplify the stylized patterns shown in Figure 2. Test your perception in the following manner looking for the main features not the detail:

1. Consider first the tree portion (dark) within each of the squares A-G.
2. Assess the percentage cover and choose the nearest percentage cover midpoint. These are given on the bottom of the Figure 3 and in Table 1.
3. Enter the number in the space to the left of the slash character provided under the "TREE" column provided in Figure 3 (i.e. **10%** / | /).
4. Match the pattern of the tree portion with one of the patterns depicted in Figure 2.
5. Enter the number in the space to the right of the slash character provided under the "TREE" column. An example is provided for case A (i.e. 10% / **11** | /).
6. Repeat steps 1-5 this time considering only the scrub portion of the squares and enter the closest matching in the "SCRUB" column (i.e. 10% / 7 | **90% / 12**).

When you have finished compare your assessments with your partner (if you have one) and against the descriptions below. The first thing to realize is that everybody's perception is different – so expect there to be differences between your answers and those of your partner(s). This fact does not invalidate the approach for two reasons. First, hopefully you will have at least two individual opinions for each station from which to construct a consensus opinion. Second, we intend to apply "fuzzy logic" analyses to HSA categorical data to account for these differences. This kind of analysis is designed specifically to deal with the statistical issues surrounding human perception and categorical data such as that generated by this protocol.

Here are our reasoned interpretations of the "organic" example we provided in Figure 3:

A: [Tree 10% / 11, Scrub 90% / 12]. Lots of differently sized and shaped tree patches. Which is the dominant habitat type? Scrub has the higher cover category so scrub is dominant and tree is subdominant. To assess the percentage of tree cover imagine all the tree habitat dropped into a square

shape in one corner. This would represent more than 5% of the total area, probably around 10%, so you enter that percentage in the cover column for tree habitat. Because there are only two habitat types, the scrub habitat must cover the remaining 90% (100% – 10%).

Although the tree coverage is high, is its spatial pattern clumped or dispersed? Obviously the choice is between the clumped Pattern #7 and the dispersed Pattern #11. We assigned Pattern #11 because we felt that Pattern #7 would be more appropriate for an area with fewer and larger patches. Consequently, habitat Pattern #12 was chosen to represent the pattern of the scrub habitat.

It is worth noting that when considering just two habitat types the cover category codes must be paired (<5% with >95%; 10% with 90%; 20% with 80%; 30% with 70%; 40% with 60%; and 50% with 50%;). Similarly, with only two habitat types, pattern codes may also be paired (#2 with #3, #4 with itself, #5 with #6, #7 with #10, #8 with #9 and #11 with #12).

B: [Tree 20% / 2, Scrub 80% / 3]. Scrunch your eyes together and what do you see? You should see that the main feature is a dark area (outlined in grey) in an otherwise white square? This represents a patch of open woodland and covers about the same area as the tree patches illustrated in (A) but arranged in a different pattern. Later we will look at the pattern *within* the patch labeled H.

C: [Tree 60% / 5, Scrub 40% / 6]. In this example the tree habitat covers close to 60% of the area, and therefore is the dominant habitat. The tree habitat is clearly divided by a wide strip of scrub habitat and is assigned Pattern #5. The complement to this for the subdominant scrub habitat would be 40% shrub cover and Pattern #6.

D: [Tree 70% / 4, Scrub 30% / 4]. This is a good example of the decisions you may have to make. The tree habitat cover is about 70% and some might choose *Dividing* (Pattern #6) for the tree habitat. Look again! The bottom left corner has many small tree patches so overall this is closer to Pattern #4 (*Edge*) than #6. Therefore, the scrub habitat is the tree habitat's cover and pattern complement of 40% cover and Pattern #4.

E: [Tree 30% / 6, Scrub 70% / 5]. The scrub habitat is obviously dominant but divided by a 30% cover of tree habitat (Pattern #5: *Dividing*). Again we entered the complementary codes for the percentage cover estimate (70%) and Pattern #6 of the scrub habitat.

F: [Tree 40% / 2, Scrub 60% / 3]. The tree habitat covers about 40% of the area arranged as a large patch (J) surrounded by scrub (Pattern #2: *Surrounded*). Scrub habitat is obviously dominant and encircles the patch (Pattern #3: *Surrounding*). Although there are other tree habitat patches present, they are minor with respect to the main features.

G: [Tree 80% / 10, Scrub 20% / 7]. Is the percentage cover of tree habitat 80% or 90%? We chose 80%. Is the pattern clumped or dispersed? For the scrub habitat we chose Pattern #7 (*Clumped – low cover*) to describe the large patches of scrub present in the bottom corners; we then chose Pattern #10 (*Clumped -high cover*) to describe the tree habitat.

Now let us look at patterns and coverage within habitat types. Tree habitat patches H, I and J are dominant or subdominant tree habitat types that have their own internal structure. Up to now you have considered H, I, and J as patches of tree habitat in a larger scrubbier area, but what is it like

inside those patches? Basically, choosing the cover and pattern codes within a habitat is what you do when filling in data for the vegetative layers on HSA Form H1. *At this stage it is important to realize that we now change scales - each of these patches is now considered as 100% and cover and pattern apply just to the patch itself.*

H: [Tree 50% / 8]. Surprisingly, within patch (H) only about 50% of the area is tree habitat arranged in fairly discrete smaller patches so its pattern is that of Pattern #8 (*Clumped – medium cover)*. In general, Pattern #8 may be typical of a tree plantation, golf course, or old orchard. Even some natural landscapes can resemble this pattern - think of riparian areas in which several channels converge (Pattern #9) leaving discrete patches of wooded bottomland (Pattern #8).

The following two examples may help you discriminate between a dispersed and a clumped pattern when percent cover of the target habitat type is high (>75%):

I: [Tree 90% / ??]. The trees are fairly continuous but with a few white patches, perhaps ~90% coverage (Cover category #10). Is this pattern closer to #10 than to #12 (discuss).

J: [Tree 90% / ??]. The trees are again fairly continuous (>90%) with a few white patches. Is the pattern closer to #10 than to #12 (discuss).

If H, I, or J were examples from your station you would be entering the cover and pattern you decided for the tree habitat in the spaces provided for “Upperstory” provided the average canopy height was greater than 15m. If average canopy height was >5m, but <15m, the cover and pattern codes would be entered for “Midstory”.

Detailed directions for completing the Habitat Structure Assessment form

The Habitat Structure Assessment form (HSA Form H1) provides space in which to record the cover and pattern of the various habitats and their constituent layers. We provide below a guide to filling in each field of those forms. We also provide, based on the example station map (Figure 1), a completed form H1 for the dominant forest habitat (Figure 4).

LOCATION CODE: Enter the four-letter code of the MAPS location to which your station belongs.

STATION CODE: Enter the four-letter code of your MAPS station.

DATE: Indicate the month, day and year on which the habitat assessment is undertaken. We recommend you do this during the fourth visit to your station (not necessarily Period 4).

SURVEYED BY: Enter your name in this space.

SURVEY: Circle the appropriate survey type. We prefer that each of at least two surveyors conduct the assessment without consulting each other. When these are complete, the discrepancies between the two forms should be discussed and a consensus opinion formulated. Fill in another set of forms to reflect this consensus opinion and circle “consensus” – remember the consensus set of forms is the

only set IBP requires. *If only a single surveyor conducts the assessment, her/his forms should be submitted to IBP with "single" circled on each form.*

HABITAT DOMINANCE CODE: Circle the appropriate dominance code to reflect the area you are describing. The letter (A, B, C, D or E) should correspond to the labeling of the habitat types marked on your station map (see page 4: Step 4).

DESCRIBE HABITAT TYPE: As most of you are familiar with the plant alliances within your station please provide a succinct description of the habitat type in your own words. The NVCS alliance codes are still being developed and the habitat description (along with the "General Description" and "Species Names"; see below) will provide ranges of data associated with alliance codes. Examples might include a forest association: "Red oak, white oak and hickory woodland with dogwood, poison ivy and muscadine vine understory." Alternatively the habitat might be non-forested: "Californian coastal sage scrub", "Old field", "Lowland wet meadow" or "Montane meadow".

SUCCESSIONAL STAGE OF HABITAT TYPE: Circle the appropriate successional stage code (late, mid or early) by which the habitat can be described. This is relative to the habitat type so that, for example, a 40-year-old mixed oak/hickory deciduous forest could be described as mid-successional but after 60-70 years the canopy might be closed and it would be described as late-successional. On the other hand, a 60-year-old redwood forest would be described as early-successional.

NATIONAL VEGETATION CLASSIFICATION STANDARD FORMATION: This is obtained from the National Vegetation Classification Standard (1997) which we have summarized in Appendices 1- 6. Appendix 1 provides the background and instructions on how to use the hierarchical classification system. Appendix 2 provides a key to the NVCS codes at the "Formation" level of the hierarchy (e.g., IA8Ng: Saturated temperate or subpolar needle-leaved evergreen forest). Appendix 3 provides a glossary of the terms used in the classification system.

Please note that "cover" in the NVCS system is defined as the sum of the areas delimited by the vertical projections of plant perimeters. There is an important distinction to be made between forest and woodland with regard to cover: generally, in a forest the crowns overlap and total cover is between 60 and 100% but in woodlands the crowns do not overlap and cover is less than 60%.

NATIONAL VEGETATION CLASSIFICATION STANDARD ALLIANCE: Appendices 4-6 provide regional lists of NVCS alliance level codes and one-line descriptions of the dominant species in those alliances (see Appendix 1 for details). Use the NVCS Formation Code to limit the options, then choose the Alliance code that best describes the habitat being assessed. If a habitat type within your station is atypical for the region and is not represented by a NVCS alliance code in your regional list, you can obtain help from IBP or choose from the regional lists provided on our website. Be sure to enter only the Alliance number in the second column of Appendices 4-6 (e.g., 16 or 100).

PERCENTAGE OF STATION COMPRISED OF THIS HABITAT TYPE: What percentage of the area of the station (within the boundaries defined in Step 2 of the step-by-step instructions) is occupied by the habitat in question? The sum of the percentages for each of the habitat types defined at the station (up to five) should generally be 100%. Small patches (<1 hectare, or <5% of the total

area) of distinct habitat types must be lumped into the habitat type they appear to be associated with and described in the vegetative (or non-vegetative) layers. For instance, the presence of a few bushes around the edges of a meadow can be described in the shrub layer of the meadow habitat description and not treated as a separate habitat.

PATTERN CODE OF THIS HABITAT TYPE: Enter the spatial pattern category (from Figure 2, also see Table 2) that best matches the pattern of the habitat type under consideration. Remember that the black cells represent the habitat type of interest and the white cells represent all other habitat types (pooled) that are present at your station.

AVERAGE HEIGHT OF TREE CANOPY: Enter the average height to the nearest 5m (or nearest 2m if the average height is less than 15m) of the tree canopy in the habitat type under consideration. Remember, trees are defined as woody, generally single-stemmed plants that are at least 5m tall at maturity. Do this regardless of whether the tree canopy extends into the upperstory, midstory, or only into the understory (see below). This can be achieved by drawing an imaginary line running through the tops the canopy whereby the area of the outlines of trees above the line equals the area of the gaps below it (*ignore gaps that reach the ground*). Estimates obtained using a clinometer are preferred but we understand that few stations have one. If you are working in a managed forest or woodland it is likely that the responsible land manager(s) can provide this information.

AVERAGE HEIGHT OF SHRUBS: Enter the average height to the nearest 0.5m of the shrubs (woody, generally multi-stemmed plants with a bushy appearance) in the habitat type under consideration. Note that when considering the understory vegetative layer (below), you will estimate the cover and pattern of all vegetation between 0.5 and 5m, regardless of whether it is comprised of trees (except trunks), shrubs, or herbaceous vegetation. Here, we are asking only for the average height of the shrubs.

AVERAGE HEIGHT OF HERBACEOUS VEGETATION: Enter the average height to the nearest 0.1m of the herbaceous (non-woody, vascular) vegetation, which includes graminoids (grass-like vegetation including grasses, sedges, rushes, etc.), forbs (broad-leaved herbaceous vegetation), and ferns. Again, note that when considering the live vegetation of the ground cover vegetative layer (below), you will estimate the cover and pattern of all vegetation below 0.5m, regardless of whether it is comprised of the seedlings of woody vegetation, herbaceous vegetation, or non-vascular vegetation (mosses and lichens). Here, we are asking only for the average height of the herbaceous (graminoids, forbs, and ferns) vegetation.

VEGETATIVE LAYERS: Divide the vegetation within each habitat into four main layers; upperstory, midstory, understory, and ground cover, based solely on their height as described below. As a general rule, the trunks of standing live or dead trees count for cover only in the highest layer that the trees reach.

Upperstory: This vertical layer encompasses all vegetation above 15m from the ground, including coniferous or broad-leaved trees, vines, and epiphytic plants and lichens.

Midstory: This vertical layer encompasses all the vegetation between 5 and 15m above the ground, including saplings and tall shrubs as well as vines, epiphytic plants and lichens, and vegetation hanging down from the upperstory level. Do not include the trunks of trees that reach into the

upperstory in the cover of this layer.

Understory: This vertical layer includes vegetation found between 0.5 and 5m above the ground and includes mainly shrubs and small saplings. In addition, this layer may also contain herbaceous vegetation extending up from the ground cover layer. Do not include the trunks of any trees that extend into the upperstory or midstory in the cover of this layer. Also, do not include the trunks of fallen trees, regardless of their size, in the cover of this layer.

Ground cover: This layer includes all the vegetation below 0.5m as well as everything on the ground. Do not include in the cover of this layer the trunks of any trees that extend above this layer or the woody stems of shrubs that extend into the understory. Do include the trunks of fallen trees. This layer is itself split into three components described below:

> **Live vegetation:** Includes seedlings of woody vegetation, grass-like vegetation (graminoids within which we include grasses, sedges, and rushes), forbs and ferns, and nonvascular vegetative ground cover (including mosses and lichens).
>
> **Dead vegetation:** Includes all the dead leaves, empty seed cases, twigs, branches and logs that lie on the ground in the habitat in question.
>
> **Total non-vegetative:** Includes bare ground covered by rock, stones or gravel, sand or dirt, water or human-made cover such as roads, parking lots and other development. ***If this sub-layer has any percentage associated with water or human-made features then the next section of the form (*****Non-vegetative layers*****) must be filled in to describe those features in detail.***

COVER: Enter the cover category (<5, 10, … 90, >95) of each of three layers (upperstory, midstory, understory) from Table 1. The cover category should represent the percentage cover of the layer **within** the habitat type and **not** the percentage cover of the area of the entire station. Imagine a meadow that has shrubs dotted over it and reshape the area into a square, pushing the shrubs into one corner. Let us say, for instance, they cover somewhere between 5% and 10% of the entire area, then you would enter 10 (to reflect the range 5-15%) into the data sheet for the understory. In the case of the ground cover layer, provide an estimate of the ***absolute percentage*** of the habitat type covered by each of the three components of the ground cover as described above: live vegetation, dead vegetation, and non-vegetative ground cover. Note that these three percentages must add up to 100%. ***It is essential to enter the cover category for at least one of these three components (there must be something on the ground!).***

PATTERN: Enter the number of the spatial pattern that the vegetative layer (or non-vegetative feature) most closely resembles (refer to Table 2 and Figure 2). Remember that black cells represent the target layer and the white cells represent all other layers (or features). Pattern code #1 might be used to describe the ground cover live vegetation of a mown, or grazed grassland habitat type. In general, pattern codes between #2 and #6 are rarely chosen for vegetative layers. Exceptions include a closed upperstory forested habitat area: a) surrounding a clearing insufficiently large enough to be considered a separate habitat type (#3: *Surrounding*), or b) with a fire road dividing it (#5: *Divided*). ***It is essential to enter a spatial pattern wherever a cover category has been supplied (except for total non-vegetative cover).***

NUMBER OF SPECIES: For each vegetative layer, we wish to assess how diverse it is in terms of number of species. Enter the number of species present. Obviously for vegetative layers that are especially botanically diverse you need only enter the approximate number of species (e.g,"~50").

VEGETATION TYPES WITHIN EACH LAYER: Within each vegetative layer, record the approximate percentage cover of woody coniferous, woody broad-leaved, (total woody for the ground cover layer), forbs and ferns, graminoids (grass-like), and non-vascular vegetation types in that layer alone. The sum of the percentages of the various vegetation types in the layer must equal 100%. For example, even though a woodland upperstory layer may only have a cover class of 30 (25-35% cover), coniferous trees may comprise 60% of the upperstory and broad-leaved trees 40% of the upperstory. In this case you should enter 60% for "Conifer" and 40% for "Broad" in the appropriate columns.

Vegetation in the middle layers may contain vegetative material originating from lower or higher layers. For instance, the understory may contain branches hanging from the upperstory or midstory, and may contain forbs, ferns, and grasses emerging from the ground cover layer. Trunk coverage in all but the highest layer the trees reach can be ignored. Each of the four layers contains differing numbers of component vegetation types – in each layer, the sum of the vegetation types must total 100%. For the upperstory and midstory layers, only three vegetation types (woody coniferous, woody broad-leaved, and forbs and ferns (which encompasses vines, epiphytic plants, and lichens)) must total to this 100%. For the understory, up to four vegetation types (woody coniferous, woody broad-leaved, forbs and ferns, and grass-like) may be present, the percentages of which still must total 100%. For the ground cover layer, up to four vegetation types may also be present, which again must total 100%. In this case, they are total woody, non-vascular (includes mosses and lichens), forbs and herbs, and graminoids (grass-like).

Circle the types of dead vegetation (leaves, twigs, branches, old logs or recent treefalls) that individually comprise 10% or more of the dead vegetation present. Also, please circle the types of non-vegetative cover (rock, stones or gravel, dirt or sand, water, or human-made) that individually comprise at least 10% of the non-vegetative cover.

MAIN SPECIES: This space allows you to list the dominant and more common species in each vegetative layer (***preferably scientific names***) or comment on the dead vegetation or non-vegetative layers. ***N.B. This information must be completed for all layers in which some cover is reported – if common names are used they must be specific (e.g., "Northern Red Oak" not just "Oak").***

NON-VEGETATIVE FEATURES: There are four kinds of non-vegetative features, that are of particular interest, which may occur within your station: running water, standing water, human-made corridors, and human-made structures. Determine the **cover and pattern** of these layers within each habitat type and enter the appropriate codes. Please note that all these features should be indicated clearly on your station map. Let us consider the types of features individually:

> **Running water:** Running water courses range in width from a seep/trickle, to a very small brook (<0.5m), a small stream (0.5-2.0m), a large stream (2.0-5.0m), a river (>5.0m) or canal. Circle the main features you see within the station but restrict the pattern of coverage to Spatial Pattern categories 4, 6 or 9 (Figure 2).

Standing water: Standing water includes ponds and lakes (<50m^2 or >50m^2), water catchment for livestock (<50m^2 or >50m^2), or marsh/bog areas (<50m^2 or >50m^2). Such water bodies may be permanent, seasonal (vernal pools) or occasional (flooded field). For example, if ponds occur within a meadow and normally have water in them year-round, then you would circle natural pond, permanent and the size category <50m^2 or >50m^2 (if both size classes occur circle both). If there is standing water at your station that does not fit any of these categories, circle other and write a brief description in the comment section.

Human-made Corridors: This category includes all linear or curvi-linear features on which vehicles, people, pack animals, and livestock travel and include roads, tracks, breaks or paths longer than 30m. Do not include net paths this category. These features may be constructed of varying types of substrate, paved, gravel, dirt, or mown. If a gravel road occurs within the station then you would circle gravel and road. If there is a human-made corridor at your station that does not fit any of these categories, circle other and write a brief description in the comment section. ***DO NOT include net paths in your consideration because all stations have net paths.***

Human-made Structures: This category includes all man-made structures such as buildings, bridges, power poles, observation towers, dams etc. Such structures are often utilized by some avian species such as nesting swallows, or perching hawks and owls. Circle those types present and indicate their positions on the station map. If there is a human-made structure at your station that does not fit any of these categories, circle other and write a brief description in the comment section

COMMENT: Provide comments, as appropriate, for each non-vegetative feature (e.g., spring fed stream, vernal pools, or 10m powerline poles).

GENERAL DESCRIPTION OF HABITAT TYPE INCLUDING HABITAT AGE: It is essential that you give a general description of the habitat type in the space provided (you may provide us with a separate sheet if necessary). This allows you to provide more detailed information than the shorter "Describe habitat type:" at the top of the form. The following example was adapted from a station description provided by a MAPS station operator:

> "Located along a small ridge between two valleys (approx. altitude in valleys is 150 m). This wooded area consists of oak (southern red predominates with some black and white), hickory, and poplar. Other species are Carolina buckthorn, ash, cherry, sweet gum, black gum, dogwood, etc. Vines are muscadine, poison ivy and rattan vine along with Japanese honeysuckle. Very little shrub undergrowth, mostly huckleberry/blueberry types."

All this information **must** be indicated on the HSA Form H1. In this case the plant species mentioned must be provided in the "Main Species" column of the upperstory, midstory, and understory layers. Also, some clearly defined options can be selected to summarize the drainage, slope, geography, ridge and aspect features of the description (see Figure 4 for a completed example based on Figure 1).

Drainage – circle one option (well-drained or poorly-drained) that best represents the drainage

characteristics of the habitat. Remember that this is relative to the normal range you would expect for that habitat type.

Slope – circle one option that best represents the topography of the habitat: flat, gently sloping, undulating or steep. This is a judgment call but not a difficult one.

Geography – indicate if the habitat is associated with a bottomland, hillside, ridgetop or plain.

Ridges - if ridges are present, circle whether there is a single dominant ridge, two, or more than two equally dominant ridges that occur within the boundaries of the station.

Aspect – this represents the orientation of the main feature to the compass points. If for instance, the station lies on a southwest-facing slope you would circle 'S' and 'W'. Circle 'none' if the terrain is flat and 'all' if the habitat type extends all the way around a hill. If you have circled "hillside" for geography, and 'S' and 'W' for aspect then we assume more than 50% of the area of the station is located on the SW facing slope of the hillside.

NUMBER OF SNAGS: Circle the number (0, <5, 5-15, >15) that best represents the number of snags present in the habitat type under consideration. ***Snags are defined as dead woody stems greater than 1m in height and greater than 10cm in diameter.***

MANAGEMENT/DISTURBANCE HISTORY: Enter a brief description of the management history (e.g., I estimate that the area was probably logged in the late 1940's/early 1950's". Then circle the appropriate option(s) describing the type of management practice or disturbance, if any apply (e.g., Year(s) occurred:1945-55 Logging:clear-cut)). The logging patterns may be indicated by circling clear cut (of at least 1 hectare), selective (small patches <1 hectare in extent, or individual trees), or a strip of trees (removed for a powerline, for example).

Briefly describe disturbances and associate them with a year or range of years, then circle the cause: fire, wind (vegetation flattened, felled or broken by storm action), scoured by flood, altered by being drained, or affected by icestorm. Other disturbances are too numerous to specify so please write them in the space provided. They might include grazing, mining, pest infestation (and subsequent application of herbicides/pesticides), glacial retreat, mowing and clearing of ground cover. In eastern and boreal areas pest outbreak may be severe in some years and this should be recorded in the notes.

A space is provided for a general description of management practices or disturbance regime. This is especially important if the practices or regime is not listed, examples might include ***'Forest understory underwent prescribed burn in 1994'*** or ***'avalanche scoured most of the west-facing slope'***. Space is available for entering the years in which disturbances occurred. Study Figures 1 and 4 to see how some of the information given on the station map translates to HSA Form H1.

In previous years our biggest problem was that some fields were not filled in for one or another reason. This is always a problem with form filling – Does a blank indicate a zero or a missed field? The most common omissions were percentages for "Vegetation types within each layer" (Conifer, Broad, Forbs and Grass-like fields), and no "Pattern" code where a "Cover" code existed. Please put a dash (-) in fields that are not applicable to indicate that you have considered them.

If you have any questions contact Dr. Philip Nott at (415) 663-2050 (pnott@birdpop.org).