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`07`

Contract No. NAS5-20915

Investigation No. 22280

Title: Use of LANDSAT imagery for wildlife habitat mapping in northeast
and east central Alaska

TYPE II Progress Report No. 2, November 1, 1975

A. Problems: The EROS Data Center reported that two scenes selected for
analysis were not available in CCT format because of poor
data quality in single bands. Data orders for alternate
scenes were similarly rejected by EDC but eventually six
scenes for which CCT data is available were eventually
selected and ordered. Therefore, the problem of CCT non-
availability has wasted time but is not critical for this
project. It is becoming a serious problem in other investigations
we are carrying out for the Sierra Foundation, the U.S. Fish
and Wildlife Service and the U.S. National Park Service.

B. Accomplishments: Portions of scenes 1029-20383 and 1408-20435 comprising
a composite total of about 1.3 scenes were analyzed using an iterative
clustering routine and maximum likelihood classification. Ground truth
definition of analytic classes was accomplished during the reporting
period (Tables 1 and 2; Appendices 1 and 2). Some classes emerging in
the analysis were equivalent on each scene (Table 3) but, because each
of the scenes contained unique ecosystems, there were classes on each
scene which had no corresponding class on the other scene. For example,

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scene 1029-20383 contained extensive alpine areas in the Alaska Range

whereas the analyzed portions of scene 1408-20435 contained no true

alpine regions. Thus, several categories of alpine vegetation in

1029-20383 had no corresponding classes on scene 1408-20435.

Similarly, a number of categories which are different stages of

revegetation of mine tailings appeared in the analysis of scene

1408-20435 but no such categories appeared in the analysis of scene

1029-20383.

All significant definable categories are being evaluated with regard

to specific moose habitat value. These evaluations are being made by

Dr. John Coady and other personnel of the Alaska Department of Fish

and Game (ADF&G). Based on these results, color coded moose habitat

maps will be prepared at 1:250,000 and 1:63,500 scale from the classified

digital tape. These products complement other ADF&G research on interior

Alaskan moose populations and will be useful in revision of the management

plan for Game Management Unit 20.

Digital tape data for five scenes (1407-20374, 1408-20430, 1734-20471,

1771-20513 and 1771-20515) have been obtained and data for scene

1422-20203 is on order. These data will be analyzed during the next

quarter. Selection of ground sampling areas and preparation of map

overlays will be accomplished during the spring quarter. Ground truth

sampling for class definitions is scheduled for next summer and habitat

calculations for these scenes will be made next fall. Color coded

habitat maps will be produced late next year and the final report

will be available by January 1977.

In summary, the project is progressing according to schedule, results

achieved to date meet previous expectations and no problems impeding

successful completion are anticipated.

C. Significant Results: Two scenes were analyzed by applying an iterative

cluster analysis to a 2% random data sample and then using the resulting

clusters as a training set basis for maximum likelihood classification.

Twenty-six and twenty-seven categorical classes, respectively, resulted

from this process. Some of these categories were undefinable because

they were rare and did not occur in large enough spatial groupings for

confident ground location and sampling. However, the majority of classes

in each case were quite specific vegetation types (Table 1 and 2;

Appendices I and II). Each of these types has specific value as moose

habitat and color coded moose habitat maps can be prepared from the

feature classified digital tapes.

The analytic process described has several major advantages for Alaskan

applications of LANDSAT data. First, all consistently differentiable

major classes emerge in the analysis. Significant information contained

in the data is not "buried" by a narrowly goal-oriented thematic analysis.

Therefore, the same analytic results may be applied to a variety of

themes such as timber, wildlife habitat and water resources. Second,

no ground truth is required initially to carry out classified data

processing and, following such processing, ground truth tasks are

clearly defined. Third, clustering and classification may be carried

out entirely on a general computer without interactive capability.

Therefore, data processing is less expensive than methods requiring use

of a specialized interactive system. Cost benefits in this regard may

exceed a 4:1 ratio. The only disadvantages of the method evident thus

far are that rare feature classes may be missed entirely in sampling

or their limited appearance in the results may not permit adequate

definition.

D. Publications:

LaPerriere, A. J. 1975. Alaskan resources, current development,

traditional cultural values and the role of LANDSAT data in

.current and future land use management and planning. NASA

Earth Resources Survey Symposium. June 8-12, 1975. Houston.

(In press.)

E. Recommendations:

None

F. Funds Expended:

$26,000.00

G. Data Use:

Data Product	Value of Data Allowed	Value of Data Ordered	Value of Data Received
CCT	$ 2,600	$ 800	$ 400
LANDSAT	3,500	---	982

H. Aircraft Data:

None

Table 1: Cluster classes for scene 1029-20383

Cluster Identifier	Brief Descriptor*
1	Birch-white spruce forest (birch dominant)
2	Black spruce heath
3	Light colored mud and rock
4	Agricultural fields
5	Early successional fire recovery: birch-willow
6	Aspen forest
7	Black spruce bog
8	Mature birch
9	Upland white spruce/birch (spruce dominant)
A	Black spruce-birch heath
B	Mature white spruce
C	Upland brush-alder
D	Moist tundra
E	_Eriophorum_ tussock meadow
F	Cottonwood
G	Mud and silt
H	Alpine tundra
I	Black spruce-tamarack muskeg
J	Deep water
K	Agricultural fields
L	**
M	Silty water
N	Shallow clear water
O	Gravel
P	**
Q	Gravel
R	**

*For more detailed description of each class see Appendix I.

**Denotes classes which are too infrequent for accurate definition. Their occurrence is sporadic, rare and groupings of pixels large enough for accurate ground location are not present. Some of these may be ecotonal classes representing mixtures of two or more classes while others may be artifacts resulting from calibration synchrony error in the scanner system.

Table 2:   Cluster classes for scene 1408–20435

Cluster Identifier	Brief Descriptor*
1	Black spruce heath
2	Mixed spruce
3	Birch-spruce forest
4	Black spruce-birch heath
5	Deep water
6	Mature birch
7	Undefined
8	Undefined
9	Silty water
A	Aspen forest
B	Undefined
C	Vegetation-water interface; combine with P
D	Undefined; probably cloud
E	Unvegetated mine tailings
F	High brush willow
G	Very sparsely vegetated sand and gravel
H	Light colored rock
I	Vegetated mine tailings
J	Mud and silt
K	Moderately vegetated mine tailings
L	Closed canopy spruce-birch forest
M	Mixed deciduous forest
N	Sparsely vegetated mine tailings
O	
P	Shallow water
Q	Mid-successional birch

*For more detailed description of each class see Appendix II.

**Denotes classes whose occurrence is too infrequent and sporadic for accurate definition.

Table 3: Category correspondence emerging from independent analyses of
          scenes 1029-20383 and 1408-20435.

Category 1029 Identifier	Category 1408 Identifier	Descriptor
2	1	Black spruce heath
B	2	Mature spruce
J	5	Deep water
N	P	Shallow water
M	9	Silty water
8	6	Mature birch
A	4	Black spruce-birch heath
6	A	Aspen forest
C		Upland brush
1	3	Birch-spruce forest
3	H	Light colored rock
G	J	Mud and silt
9	L	Spruce-birch forest

Appendix I: Description of cluster classes on scene 1029-20383

Class 1 -- Upland birch-white spruce: Areas dominated by young paper birch

(Betula papyrifera) but containing some white spruce (Picea

glauca) on relatively well drained sites. The shrub story is

fairly well developed and consists of alder (Alnus ssp.) and

willow (Salix ssp.). The ground cover is dominated by blueberry

(Vaccinium uligonosum) and low bush cranberry (Vaccinium vitis-

idaea) but Cornus canadensis, Rhodendron lapponicum, Epilobium

latifolium, Empetrum nigrum and moss also occur.

Class 2 -- Black spruce heath: Pure stands of stunted growth form black

spruce (Picea mariana) 3 to 5 meters in height. There is almost

no tall shrub story although Salix planifolia and Rosa acicularis

are occasionally present. These areas are poorly drained and ground

cover is dominated by spaghnum moss. Other vegetation such as

Vaccinium uligonosum, Vaccinium vitis-idaea, Ledum decumbens,

Rubus chamaemorus, Empetrum nigrum, Petasites hyperboreus, fungi,

foliose lichen and fruticose lichen are commonly present but not

abundant.

Class 3 -- Light colored mud and rock.

Class 4 -- Agricultural fields

Class 5 -- Mid-successional burn recovery/birch-willow: Dense stands of
relatively young paper birch (Betula papyrifera) mixed with tall
willow (Salix ssp.). Most of the birch are saplings but birch
which has reached tree size is fairly common. Many white spruce
(Picea glauca) saplings are present but very few have achieved
tree size. There is no medium height shrub story and the major
components of the ground cover are litter, Equisetum and Linnaea
borealis.

Class 6 -- Aspen forest: Pure stands of mature aspen in a late successional
state. No aspen regeneration is occurring and most all aspen
saplings are dead or dying. White spruce are invading but very
few have reached sapling size. The shrub story consists of low
density Salix ssp. 2 to 6 meters in height and Rosa acicularis.
Ground cover is dominated by leaf litter but patches of moss,
lichen, Ledum ssp. and Vaccinium vitis-idaea are commonly present
but not abundant.

Class 7 -- Black spruce bog: Poorly drained sites with poor growth form
black spruce (Picea mariana) and an occasional tamarack (Larix
larcina). Tall shrubs include Salix ssp. and Alnus ssp. Ground
cover is dominated by moss but a variety of other species are
commonly present: Potentilla fruticosa, Spirea beauverdiana,
Vaccinium uligonosum, Vaccinium vitis-idaea, Vaccinium oxycoccus,
Rubus chamaemorus, Ledum groenlandicum, Arctostaphylos rubra,

Chamaedaphne calyculata and Equisetum ssp.

Class 8 — Mature birch forest: Areas of large paper birch with very
limited reproduction. Saplings of any tree species were quite
rare. A well developed shrub story of tall willow and alder
exists along with a secondary shrub story consisting of high
bush cranberry (Viburnam edule) and wild rose (Rosa acicularis).
Litter dominates the ground cover but moss, grass, Equisetum,
Epilobium, Mertensia, Linneae borealis and Cornus canadensis
are commonly present.

Class 9 — Upland white spruce-birch (spruce dominant): Mature white spruce-
paper birch forest on upland sites. The shrub layer consists of
Alnus, Rosa, Viburnum and Ribes. Ground cover is dominated by
litter, grass, moss and Equisetum.

Class A — Black spruce-birch heath: Black spruce (Picea mariana) in variable
growth form ranging from poor to moderate. These areas are, as a
whole, poorly drained but paper birch occurs mixed with moderate
growth black spruce on slight rises which have better drainage.
A sparse understory of willow and alder exists and the ground
cover is primarily moss and ericaceous heath. Tamarack (Larix
larcina) also occurs sparsely mixed with black spruce.

Class B — Mature white spruce: Mature climax forest consisting almost

exclusively of very large white spruce. A few large paper birch and paper birch saplings are mixed in the forest but, in general, there is very little tree reproduction. The canopy is almost completely closed but the ground is relatively open and easily traveled on foot. Rosa and Viburnum occurs in low density and ground cover is dominated by moss.

Class C — Upland brush-alder: Moist tundra dotted with clumps of Alnus. Ground cover is dominated by moss, Carex, Petasites, Polygonum, Vaccinium uligonosum, Vaccinium vitis-idaea, Ledum decumbens and Betula nana.

Class D -- Moist tundra: Relatively homogenous low growth moist heath tundra. Few plants on these areas exceed .3 m in height. Salix shrubs may be present but sparsely distributed and inconspicuous. Ground cover consists of moss, Betula nana, Vaccinium vitis-idaea, Vaccinium uligonosum, Ledum decumbens, Carex ssp., Empetrum nigrum, Arctostaphylos alpina, Polygonum bistorta, Rubus chamaemorus and Pedicularis ssp. Some Eriophorum vaginatum tussocks occur near small pools and in wetter depressions but are not abundant.

Class E — Eriophorum tussock meadow: Poorly drained areas dominated by Eriophorum tussocks with moss and sometimes standing water between the tussocks. Vaccinium uligonosum, Vaccinium vitis-idaea and Ledum are commonly present in the ground cover. Betula glandulosa

and several _Salix_ ssp. especially _Salix planifolia_ form a moderate to low density shrub story. Trees may be present at very low density and poor growth form or entirely absent. If trees are present, they usually are isolated spruce or tamarack in stunted growth form.

Class F -- Cottonwood: Mature stands of large balsam poplar (_Populus balsamifera_). The shrub story consists of low density tall willow and lower shrubs such as _Rosa acicularis_ and _Viburnum edule_. Litter dominates the ground cover but grass, _Shepherdia canadensis_, _Linnaea borealis_, moss, fungi, _Mertensia_, _Aconitum_ and _Equisetum_ are commonly present.

Class G -- Mud and silt.

Class H -- Alpine tundra: Ground cover is dominated by bare rock and _Dryas octapetala_. Other alpine plants which may be commonly present include _Oxytropis nigriscens_, _Sythrisis borealis_, _Castilleja caudata_, _Artemesia artica_, _Arnica_, _Minuartia_, _Potentilla uniflora_, _Polygonum bistorta_, _Anemone narcissiflora_, _Silene acaulis_, _Carex_ ssp., grass, several species of prostate willow and others.

Class I -- Black spruce-tamarack muskeg: These areas are similar to other black spruce classes (2, 7 and A) but contain a higher proportion of tamarack than any other black spruce class. Tree dbh is normally

small but density is relatively high. The shrub story is
relatively low density and consists of Rosa and Salix. Ground
cover is dominated by spaghnum moss but Equisetum, Vaccinium
uligonosum, V. oxycoccus, V. vitis-idaea, Ledum ssp., Carex ssp.,
Rubus chamaemorus, Empetrum nigrum, Petasites ssp., Chamaedaphne
calyculata and Arctostaphylos rubra may be commonly present.

Class J -- Deep water.

Class K -- Agricultural fields.

Class L -- Undefined.

Class M -- Silty water.

Class N -- Shallow clear water.

Class O -- Gravel.

Class P -- Undefined.

Class Q -- Gravel.

Class R -- Undefined.

Appendix II:· Definition of cluster classes on scene 1408-20435

Class 1 — Black spruce heath: Relatively dense black spruce (<u>Picea</u> <u>mariana</u>)

in poor growth form. Tall shrubs are primarily sparsely distributed

<u>Salix</u> and the ground cover is dominated by moss and litter. Foliose

lichen and ericaceous heath-complex species are commonly present

in the ground cover.

Class 2 — Mixed spruce forest: Mostly closed canopy forest consisting of

white (<u>Picea</u> <u>glauca</u>) and black (<u>P</u>. <u>mariana</u>) spruce in good growth

form. Deciduous trees are quite rare in these areas and the shrub

story consists of <u>Salix</u> ssp., <u>Rosa</u> and some <u>Alnus</u>. Ground cover

varies with the extent of canopy closure and is ericaceous heath ·

in more open locations but dominated by litter in more shaded areas.

Class 3 — Birch-spruce forest: Mixed forest dominated by paper birch (<u>Betula</u>

<u>papyrifera</u>) mixed with <u>Picea</u> <u>glauca</u> and/or <u>P</u>. <u>mariana</u>. The tall

shrub story is dominated by <u>Alnus</u> and/or <u>Salix</u> but <u>Viburnum</u> and ·

<u>Rosa</u> are usually also present. Ground cover is dominated by moss

and litter but grass, fungi, <u>Cornus</u> <u>canadensis</u>, <u>Equisetum</u>, <u>Vaccinium</u>

<u>uligonosum</u>, <u>Vaccinium</u> <u>vitis-idaea</u>, <u>Spirea</u> <u>beauverdiana</u>, <u>Linnaea</u>

<u>borealis</u> and <u>Ledum</u> ssp. are commonly present.

Class 4 — Black spruce-birch heath: Poor growth form black spruce mixed with

a small amount of paper birch. The shrub story is very low density

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consisting of occasional _Alnus_ ssp. or _Salix_ ssp. and ground

cover consists of ericaceous heath complex species.

Class 5 — Deep water.

Class 6 — Mature birch: Closed canopy paper birch forest with large

mature trees and very few saplings present. A well developed

alder shrub story exists and ground cover is dominated by litter

and _Equisetum_ ssp.

Class 7 — Undefined*.

Class 8 — Undefined*.

*Note: These classes are rare being represented by only 13 and 10 pixels

respectively but I believe they are real. Both are very high

reflecting in the _red_ band; they are closely related to one another.

Class 8 has small cluster distances to "bare rock" and water classes

such as C, G, J and N. Both are probably foliage color against

different ground cover backgrounds.

Class 9 — Silty water.

Class A — Aspen forest: Forested areas dominated by _Populus tremuloides_

mixed with occasional _Populus balsamifera_ and/or _Betula papyrifera_.

Tall shrub cover consists primarily of <u>Rosa acicularis</u>, <u>Viburnum edule</u> and some <u>Salix</u> ssp. Ground cover is dominated by litter but <u>Equisetum</u> ssp., <u>Arctostaphylos uva-ursi</u> and <u>Mertensia</u> ssp. may be locally abundant. <u>Linnae borealis</u>, <u>Vaccinium uligonosum</u>, <u>Vaccinium vitis-idaea</u>, <u>Ledum</u> ssp. and others may be commonly present.

Class B — Undefined (<u>Note</u>: High reflecting in red and relatively closely related to classes 7, 8, A (Aspen), (Upland brush) and K (moderately vegetated mine tailings). Probably bright foliage brush against unvegetated light colored ground, e.g., bright foliage brush on a largely unvegetated gravel bar.

Class C — Vegetation-water interface; combine with P.

Class D — Undefined; probably cloud.

Class E — Unvegetated mire tailings.

Class F — High brush willow: Early successional fire recovery with many standing dead trees but only a few sparsely distributed living trees. Shrub story consists of moderate to high density <u>Salix</u> ssp. 1 to 2 meters in height. Ground cover is dominated by litter, ericaceous plants and <u>Equisetum</u> ssp. Approximately 1/3 browse (moose) on the 6 to 8 species of <u>Salix</u> present.

Class G -- Very sparsely vegetated sand and gravel.

Class H -- Gravel; aircraft strips, roads, etc.

Class I -- Vegetated mine tailings: Mixed deciduous trees consisting of paper birch, aspen and cottonwood with an understory of willow and alder. Litter dominates the ground cover but as much as 40% bare rock may be present.

Class J -- Mud and silt: Sparsely vegetated mud and silt on river islands. Small patches of gravel, pioneer willows and isolated clumps of grass, sedges and <u>Juncus</u> may be present.

Class K -- Moderately vegetated mine tailings: Mixed deciduous trees (paper birch, aspen and cottonwood) at low density. A low density shrub story of willow is present and ground cover is dominated by bare rock (up to 90%).

Class L -- Closed canopy spruce-birch forest: Relatively dense mixed spruce in moderate growth form occurring with paper birch. Black spruce dominates. The shrub story is relatively low density and consists principally of <u>Alnus</u> ssp. and <u>Rosa acicularis</u>. Moss dominates the ground cover but <u>Equisetum</u> ssp. and ericaceous plants commonly occur.

Class M -- Mixed deciduous forest: Mature forest consisting of aspen, paper

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birch and some balsam poplar. The shrub story consists of tall
willows and a lower story of high bush cranberry and wild rose.
Litter dominates the ground cover but Cornus canadensis and
Epilobium angustifolium are common. Mertensia paniculata, Linnaea
borealis, Galium boreale, Pyrola ssp. and Lycopodium may be locally
abundant depending upon the dominant tree species.

Class N -- Sparsely vegetated mine tailings: Mixed deciduous trees (birch,
aspen and balsam poplar) invading in favorable locations. Willows
and alder are also invading but the ground cover is almost 100%
bare rock. The only other vegetation commonly occurring in ground
cover is Epilobium angustifolium and lichens.

Class O -- Undefined.

Class P -- Shallow water.

Class Q -- Mid-successional birch: Closed canopy forest dominated by paper
birch trees and numerous saplings. Small clumps of aspen may be
occasionally present. The shrub layer is moderate density and
consists of Rosa, Viburnum and Ribes. Ground cover is dominated
by litter and Equisetum.