EVALUATION OF TECHNIQUES USED TO STUDY VEGETATION AND AVIFAUNA IN NATIONAL PETROLEUM RESERVE OF ALASKA
1976 NPRA FINAL REPORT

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Naval Petroleum Reserve Number 4 (NPR-4) was established in 1923 and consists of about 37,000 square miles that includes the Arctic Mountain Province north through the Arctic Foothills and Arctic Coastal Plain Provinces (Fig. 1). Oil exploration and seismic work was started by the U. S. Navy as early as 1944 with over 60 wells drilled to date. Exploration by Husky Oil Company under contract to the U. S. Navy was initiated in 1975 with one well drilled in Zone A near Teshekpuk Lake. Five additional wells will be drilled in Zone A (see Fig. 1) during the winter of 1976-77. The Naval Petroleum Reserves Production Act of 1976 (PL 94-258) requires protection of surface values including fish and wildlife resources. Responsibility for management of surface values within NPR-4 was transfered from the U. S. Navy to the Bureau of Land Management within the Department of Interior in 1976 at which time the name was changed to National Petroleum Reserve of Alaska (NPRA).

The USFWS, Special Studies, instituted a study in NPRA in the summer of 1976 through a contract to Milton W. Weller. Weller outlined some long range surface management objectives designed to: (1) establish population data on waterfowl and other birds of key production areas such as Teshekpuk Lake and the Colville River Delta prior to development for oil removal, (2) relate developmental activities such as road building and pipeline construction to ecological changes in wetlands, (3) further document the relationship between aquatic invertebrates used by waterbirds and their emergent vegetation substrate, (4) relate changes in water levels to changes in vegetation and invertebrate populations vital to waterbirds and (5) assess use of coastal wetlands by migratory birds and denote important areas to be protected.

Preliminary work in 1976 in NPRA to meet the long range goals outlined above included the following objectives: (1) evaluate low-level 35mm aerial photo techniques for Arctic Slope vegetation mapping, (2) determine bird and plant species composition as a ground-truth basis for aerial census and mapping, (3) determine the feasibility of ground work on new study sites selected from maps and (4) explore logistics support for aerial census and mapping operations.

Field personnel included: D. V. Derksen, J. C. Franson, M. J. Jacobson, M. S. Jensen, T. C. Rothe and M. W. Weller.

METHODS

Aerial Photography

Equipment.--A Canon* F-1 system was used to secure vertical aerial photos. Equipment included a Canon F-1 body, motordrive unit, outside battery pack (handle), 28mm, 50mm and 135mm lenses, remote shutter release, Gossen Luna Pro light meter, 1A (haze) and Wratten #12 (yellow) filters. A side mount was constructed by the University of Minnesota Institute of Agriculture, Forestry and Home Economics Remote Sensing Laboratory (RSL) for obtaining near vertical photography.

Location of overflights.--Overflights of Storkersen Point were made of the pond areas east of Big Lake and Phalarope Lake (Figure 2). These areas were selected because of their well developed beds of *Arctophila fulva* and *Carex aquatilis* that provided excellent sites for film/filter/scale tests and 35mm vegetation plot mapping. Color infrared and color films were tested at scales of 1:3000, 1:6000, 1:12000 and 1:25000. These tests were conducted with a side-mounted camera on a Cessna 206 contracted from Sea Airmotive, Inc. at Deadhorse. In addition, the 18 km^2 Storkersen Point study area was photographed with Kodacolor II film at a scale of 1:25000. Photographic operations for this overflight were conducted through the cargo hatch of a de Havilland Beaver flown by James King, USFWS flyway biologist.

On the Colville River Delta, 1:12000 Ektachrome X coverage was obtained of Anachlik Island (Figure 3). Extensive ground truth was available for this area which will provide good signature-feature correlation for Colville River vegetation. In addition, 1:12000 Ektachrome X coverage was obtained of 31, one-half mile square vegetation

* Use of trade names does not necessarily mean U. S. Government approval.

plots. These plots were randomly located within the transects used for aerial census of birds.

A synopsis of the 1976 aerial photography program is presented in Appendix A.

Flight planning.--Flight plans were constructed using 35mm coverage and exposure interval tables developed by the University of Minnesota Remote Sensing Laboratory (RSL) (Figures 6 and 7). Exposure intervals were selected to obtain 60% endlap (40% forward gain) on sequential photographs. Flight lines for Storkersen Point projects were ruled on 1:24000 USGS orthophotomaps and for the Colville River Delta on 1:63360, USGS quadrangles.

Films and exposure.--The four basic Kodak films employed in 1976 overflights were true color films, Ektachrome X and Kodacolor II and color infrared films (CIR), Ektachrome IR-Type 2236 and Aerochrome IR-Type 2443. Kodacolor II is a color negative film for production of prints and the others are color positive (reversal) films for production of slides. Aerochrome IR-Type 2443 is only available in large quantities (35, 150 foot rolls) and was purchased through the RSL.

Camera exposure settings were determined with a hand-held Gossen Luna Pro lightmeter. During side-mount operations, readings were taken vertically on the shadow side of the aircraft to avoid fuselage reflection. During overflights with the Beaver, readings were taken through the cargo hatch. Typical exposure settings on the North Slope were f4-f5.6 at 1/500 sec. for CIR film (ASA100) and f2.8-f4 at 1/500 sec. for Ektachrome X (ASA64) and Kodacolor II (ASA80).

Color films were exposed through a 1A haze filter and the CIR films were exposed through a #12 (Wratten equivalent) yellow filter.

Recording.--All flight data including date, film, filter, scales, time of photography, location, exposures, weather, and flight problems were recorded on a 35mm log card developed at the RSL. Each exposed roll of film was labeled with a number on the cassette canister and recorded on the 35mm flight log.

Film processing and cataloguing.--All exposed film was taken to Anchorage at the end of the field season for local (E-4) processing, but the Kodacolor film had to be sent to a Kodak Processing Laboratory. The reversal film was processed in strip form and stored in transparent sleeves. The 35mm flight logs were then taped onto the sleeves, labeled with the film roll number, and, together with corresponding flight plan map, collected into a three-ring, hard-cover binder. Transparencies selected for mapping were placed in ventilated glass slides and labeled with the date, film, filter, scale, roll number and slide number. Slides were also stored in transparent sleeves and placed in the 3-ring binder.

Mapping and interpretation.--Mapping of the vegetation at Phalarope Lake and the Big Lake pond area was accomplished by use of a 14x14-inch easel-type rear projection screen and a 35mm Kodak carousel projector. The system was "plumbed" by adjusting the screen and/or projector until the X and Y directions of a projected grid slide were equal. Sequential 1:3000, CIR and color transparencies were then projected to an approximate scale of 1:300, and detail delineated on transparent acetate overlays attached to the screen. A base map was then drafted from the overlays either by direct transfer of detail or, in the case of excessive scale variation, by means of the Bureau of Land Management overhead reflecting projector.

The photo mosaic of Storkersen Point was prepared from 1:9000 (approximate) scale Kodacolor print enlargments of the original 1:25000 scale negatives. The 60% overlap on sequential photographs resulted in two complete sets of photographs--one for mosaic construction and one for stereo analysis or field checking. The mosaic was constructed by (1) trimming adjacent prints to include an area slightly greater than one half the overlap, (2) registering the detail between adjacent prints, and (3) gluing the prints to a hard surface. Section corners were then annotated on the completed mosaic.

Colville River Delta Aerial Bird Census

Six one-eighth by eight mile transects were selected within the Colville River Delta (Figures 4 and 5). Only large birds (loons, waterfowl, plovers, jaegers, gulls, terns and owls) were included in the census. Observations were logged on a standard form (Appendix B). Observations of birds were also recorded on magnetic tape for later comparison with hand-recorded information. Transects were flown in a Cessna 206 at an elevation of 150 feet and indicated air speed of 90 mph. Two observers, each responsible for 110 yards on his side of the aircraft, were seated behind the pilot and the recorder-navigator. Ice conditions on lakes within the transects were recorded on USGS quadrangle maps (Figures 4 and 5).

Colville River Delta Ground Observations

Ground comparison counts of birds were conducted at several locations in the Colville River Delta in July. Because of the lack of helicopter support no effort was made to census the aerial transects by foot. Bird species composition was determined on foot on Anachlik Island and by skiff in areas accessible via several channels (Figures 3 and 4).

Anachlik Island was censused by four observers walking abreast in a southwest direction and returning to the northeast to complete the count. Four observers and a local guide, Mark Wartes, censused channels and islands from a 16 foot skiff (Figures 3 and 4).

Teshekpuk Lake Ground Observations

Bird surveys were made on foot by four observers on a study site west of Teshekpuk Lake (Figure 8). In addition, observations of birds were made from an Avon raft (Figure 8). Plants were collected along the same transect surveyed for birds.

RESULTS

Aerial Photography

Film/Filter/Scale tests.--There appears to be little difference in the capability of CIR and color films to detect and separate *Arctophila fulva* and *Carex aquatilis* at this particular vegetation stage. However, CIR was superior to color film for differentiating *Arctophila fulva* from open water - a particularly significant problem on color film on Phalarope Lake and the Big Lake pond area. CIR film was also superior to color film for differentiating areas of standing water and wet tundra from dry tundra. There was no observed difference between CIR Type 2236 and Type 2443. However, past RSL experience suggests that in many cases, Type 2443 highlights subtle color differences among features more so than Type 2236.

Haze (1A) and yellow (Wratten 12) filters for color and CIR photography, respectively, were adequate for detection of emergents and other vegetation. The CIR photography tended to develop to a uniform bluish cast as a result of the large amount of flooded tundra and the tendency of tundra vegetation to remain in a seemingly perpetual cured state. The use of a Wratten 15 filter (orange) may "warm" the scene which would increase the red rendition thereby highlighting color differences among resource features.

Testing of scales was done to determine the smallest possible scale (largest area coverage per photograph) that could be used to adequately detect and separate _Arctophila fulva_ and _Carex aquatilis_ beds. Comparative analysis of the four scales (1:3000, 1:6000, 1:12000 and 1:25000) suggests that extensive and homogeneous _Arctophila_ and _Carex_ beds can be identified on scales as small as 1:25000. However, for accurate detection and delineation of small or marginal emergent beds characteristic of the small pond regime, an orginal scale of 1:6000 or larger will be required.

The effect of oil development (e.g., well sites, winter roads, bulldozer operations) can easily be detected on both CIR and color film at scales as small as 1:25000. However, detection of oil and seismic exploration effects (e.g., rolligon tracks) usually requires scales of 1:12000 or larger.

Season-signature effects.—The optimum time for detection of _Arctophila_ and _Carex_ on the North Slope appears to be the first or second week of August. At this time, both species are at or near peak of vegetation development with _Carex_ visually appearing bright green and _Arctophila_ reddish-green. Analysis of the early August photographs suggest that the _Arctophila_ was just beginning to tassel, thereby highlighting differences between the _Arctophila_ and _Carex_. If the field season were extended to the middle of August to take advantage of this phenological difference, better discrimination of emergents at smaller scales may be possible.

<u>Mosaic analysis</u>.--The photo mosaic of Storkersen Point provided a pictorial overview of the area's land and water resources. The mosaic was useful for (1) assessing the general drainage patterns (e.g. Fawn Creek), (2) assessing tundra damage and oil development (e.g. caterpillar scars on the Big Pingo, Storkersen well pond and winter road), (3) determining lake size and configuration, and (4) general location of vegetation beds. A particularly interesting feature on the mosaic was the apparent color dichotomy of ponds. A few ponds appeared dark brown to black in contrast to the majority that photographed light brown to orange. Investigation revealed that darker ponds were deeper and had more <u>Arctophila</u>. This color difference may be a useful technique for broad "first level" pond analysis over large areas.

The mosaic was also useful in establishing the exact location of the larger scale 35mm vegetation photo plots--an important procedure if these plots are to be reflown at some future time.

<u>Mapping</u>.--Larger scale (1:300) vegetation maps were prepared of the Big Lake pond area and a portion of Phalarope Lake. The classification scheme included <u>Arctophila fulva</u>, <u>Carex aquatilis</u>, open water and tundra. Adequate ground truth data were not available to further delineate the vegetation. The type map of Phalarope Lake is presented in Figure 9 and maps of the Big Lake pond area are presented in Figures 10-12. Although the maps were compiled from 1:3000 (original scale) transparencies enlarged to 1:300, it is apparent that original scales of 1:6000 should be adequate for vegetation mapping.

No mapping was attempted on the Colville River Delta because (1) the 1:12000 scale was too small to adeqautely detect emergent vegetation,

(2) there were no detailed maps or aerial photography for exact location of the 35mm photography and (3) there was little available ground truth for the area.

Colville River Delta Aerial Bird Census

Table 1 shows a summary of the breeding bird census flown on the Colville River Delta on June 27, 1976. Transects intersected a diversity of habitat types including wetland classes I through VI (Bergman et. al. 1976), dry and flooded river channels, sand dunes and dry tundra. Some of the larger lakes were ice-covered (Figures 4 and 5) except for an open perimeter used by Oldsquaw and loons. Number of birds per km^2 is provided in Table 2.

Colville River Delta Ground Observations

Results of bird surveys made on Anachlik Island (Figure 3) and the skiff course (Figures 3 and 4) are presented in Table 3.

Teshekpuk Lake Ground Observations

Results of bird surveys and plant collections made at Teshekpuk Lake are presented in Tables 4 and 5, respectively.

Bird species composition at the Teshekpuk Lake study site was similar to the Colville River Delta (Tables 3 and 4), but estimated species abundance varied between the two sites. The Colville River Delta site was mostly low, moist tundra with extensive fused low-center, Class II and III (Bergman et al. 1976) polygon lakes. Aerial transects intersected wetland Classes I through VI, and Class VIII salt marsh dominated by Puccinellia sp. was extensive on the northeast end of Anachlik Island. Sites examined at Meade River and Teshekpuk Lake were both upland areas with extensive dry tundra and limited numbers of wetlands.

Table 1. Colville Delta Aerial Breeding Bird Survey.

Date: 6-27-76
Time: 1600-1700
Observers: Derksen, Rothe
Recorder: Franson

Weather: 800' Broken
Ground Speed: 90 mph
Altitude: 150'
Aircraft: Cessna 206

Species	1 pr	1 ♂	1 ♀	2 pr	2 ♂	2 ♀	3 pr	3 ♂	3 ♀	4 pr	4 ♂	4 ♀	5 pr	5 ♂	5 ♀	6 pr	6 ♂	6 ♀	Totals pr	Totals ♂	Totals ♀
Arctic Loon	2	0	0	0	1	0	2	4	0	2	1	0	1	0	0	3	2	0	10	8	0
Red-throated Loon	0	0	0	0	2	0	0	2	0	0	1	0	0	0	0	2	0	0	2	5	0
Common Loon	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0
Unidentified Loon	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0
Whistling Swan	0	0	0	1^f	0	0	0	2	0	1	3^a	0	0	2	0	1^n	1^n	0	3	8	0
Black Brant	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	0
White-fronted Goose	0	1	0	1^f	1^f	0	0	0	0	0	4^f	0	0	5^f	0	1	23^f	0	2	34	0
Snow Goose	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1^n	0	0	2	0
Pintail	0	4^u	0	0	0	0	0	2^u	0	0	1	0	0	3	0	0	4	0	0	14	0
King Eider	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1
Spectacled Eider	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unidentified Eider	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Oldsquaw	0	0	1	2	1^u	0	2	0	1	0	1	0	0	2^u	0	0	1^u	0	4	5	2
Unidentified Merganser	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0
Unidentified Duck	0	0	0	0	2^u	0	0	2^u	0	0	0	0	0	0	0	0	0	0	0	4	0
Unidentified Plover	0	0	0	0	0	0	0	1^u	0	0	0	0	0	0	0	0	0	0	0	1	0
Parasitic Jaeger^f	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0
Unidentified Jaeger^f	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0
Glaucous Gull^f	0	1	0	0	0	0	0	0	0	0	1^n	0	0	0	0	0	0	0	0	2	0
Sabine's Gull^f	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0
Arctic Tern^f	1	1	0	0	4	0	0	5	0	0	2	0	0	2	0	0	5	0	1	19	0
Short-eared Owl	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0

nesting
f flying
unidentified sex
one of these birds was on a nest

Table 2. Number of birds per square area in the Colville River Delta.

Species	6 Transect Total[a]	No./mi^2	No./km^2
Arctic Loon	28	4.67	1.80
Red-throated Loon	9	1.50	0.58
Common Loon	1	0.17	0.07
Unidentified Loon	2	0.33	0.13
Whistling Swan	14	2.33	0.90
Black Brant	3	0.50	0.19
White-fronted Goose	38	6.33	2.43
Snow Goose	2	0.33	0.13
Pintail	14	2.33	0.90
King Eider	2	0.33	0.13
Spectacled Eider	0	0.00	0.00
Unidentified Eider	2	0.33	0.13
Oldsquaw	13	2.17	0.83
Unidentified Merganser	3	0.50	0.19
Unidentified Duck	4	0.67	0.26
Unidentified Plover	1	0.17	0.07
Parasitic Jaeger	2	0.33	0.13
Unidentified Jaeger	2	0.33	0.13
Glaucous Gull	2	0.33	0.13
Sabine's Gull	1	0.17	0.07
Arctic Tern	21	3.50	1.35
Short-eared Owl	1	0.17	0.07

[a] from Table 1.

Table 3. Birds observed at Helmerick's Camp, Colville River Delta, 19-20 July 1976 by D. V. Derksen, M. Jacobson, M. Jensen and M. W. Weller. Arranged in order of estimated abundance.

Waterfowl	Sandpipers
1. Oldsquaw	1. Pectoral Sandpiper
2. Black Brant	2. Semipalmated Sandpiper
3. King Eider	3. Red Phalarope
4. Whistling Swan	4. Dunlin
5. Pintail	5. Northern Phalarope
6. Red-breasted Merganser	6. Ruddy Turnstone
	7. Black-bellied Plover
	8. Bar-tailed Godwit
	9. Baird's Sandpiper
	10. Golden Plover

Loons	Gulls and Terns
1. Red-throated Loon	1. Arctic Tern
2. Arctic Loon	2. Sabine's Gull
3. Yellow-billed Loon	3. Glaucous Gull
	4. Pomerine Jaeger
	5. Long-tailed Jaeger
	6. Parasitic Jaeger

Terrestrial
1. Lapland Longspur
2. Snow Bunting
3. Willow Ptarmigan (droppings)
4. Short-eared Owl
5. Golden Eagle

Table 4. Birds observed at Teshekpuk Lake, NARL Camp, July 16-18, 1976 by D. V. Derksen, M. Jacobson, M. Jensen and M. W. Weller. Arranged in order of estimated abundance.

Waterfowl

1. Oldsquaw
2. Black Brant
3. Pintail
4. King Eider
5. White-fronted Goose
6. Scaup (unidentified)
7. Whistling Swan

Loons

1. Arctic Loon
2. Red-throated Loon
3. Yellow-billed Loon

Terrestrial

1. Lapland Longspur
2. Snow Bunting
3. Willow Ptarmigan

Sandpipers

1. Pectoral Sandpiper
2. Semipalmated Sandpiper
3. Dunlin
4. Red Phalarope
5. Ruddy Turnstone
6. Long-billed Dowitcher
7. Northern Phalarope
8. Golden Plover
9. Black-bellied Plover

Gulls and Terns

1. Glaucous Gull
2. Arctic Tern
3. Pomerine Jaeger
4. Long-tailed Jaeger
5. Parasitic Jaeger
6. Sabine's Gull

Table 5. Plant species recorded along the bird survey transect at Teshekpuk Lake, 18 July 1976. Collected by D. V. Derksen, M. Jacobson, M. Jensen and M. W. Weller, and identified by C. Franson and T. Rothe.

Poa lanata	*Cassiope tetragona*
Eriophorum vaginatum	*Pedicularis capitata*
Carex aquatilis	*Potentilla* sp.
Carex sp.	*Dryas integrifolia*
Hippurus vulgaris	*Pyrola grandiflora*
Caltha palustris	*Alopecurus alpinus*
Salix pulchra	*Polemonium boreale*
Salix reticulata	*Saxifraga punctata*
Potentilla hyparctica	*Vaccinium vitis-idaea*
Pedicularis sudetica	*Hierochloe alpina*
Rubus chamaemorus	*Pedicularus Langsdorffii*

DISCUSSION

Aerial Photography

The 1976 aerial photography objectives were directed toward organization and testing. Specific problems encountered during the field season included: (1) organization and application of the 35mm system, (2) aircraft scheduling; (3) weather conditions, (4) use of camera mounts, (5) turnaround and field checking, and (6) contracting for BLM photography.

The original approach to monitoring vegetation changes on the Colville River Delta was to photograph and map a series of randomly located, 160 acre, vegetation plots. A scale of 1:25000 was planned but 1:12000 was used because of overcast conditions. These plots could be reflown at some future time to assess vegetation changes occurring over the interim between coverages.

After analysis of the photography, it was concluded that this system did not provide enough intensive and/or extensive information on vegetation or other surface features.

During the 1976 field season, it became obvious that relying on one contractor for aircraft procurement for North Slope aerial photography operations needs to be reevaluated. Some of the problems encountered included: (1) failure of some pilots to fly straight flight lines, (2) the uncooperative attitude of certain pilots, (3) the low priority of USFWS projects for aircraft scheduling, (4) high contracting rates (e.g., $262/hour originally for a Cessna 206, later reduced to $185/hour), and (5) variation in pilots assigned to the job. Alternative sources of aircraft for the 1977 field season should be evaluated in light of the type and cost of operations desired (e.g., side mount, floor mount, high stage 35mm versus 9x9-inch coverage), photo experience of pilots, and availability of aircraft during the crucial peak of vegetation development.

Clouds and ground fog were continual problems on the North Slope and only a few clear days may be available each month for aerial photography operations. For example, during the last two weeks of the 1976 field season near the peak of vegetation development, only two half days and one full day of clear weather were available for aerial photography overflights.

Side and belly camera mounts for low level 35mm aerial photography each have advantages. The side mount was designed and built by the RSL for use on any unmodified high-wing aircraft provided struts or pontoons do not interfere with the camera field of view. It is ideal for local field situations where aircraft equipped with a camera port or cargo hatch are not available. Its main disadvantages include: (1) lack of correction for crab, (2) inability to use lenses with focal lengths shorter than 50mm, (3) inability to fly long or parallel lines of coverage and (4) the need to have the photographer's head and arms out of the aircraft window. Exposure of the face and hands is a hazard since summer temperatures range from 30-45°F on the Beaufort Sea Coast and are reduced to -5°F via air speeds of 100 mph. Side mount operations are oriented to coverage of specific objects (e.g., a pond, a vegetation bed), short line coverage (3-4 photos), or small area coverage usually no more than 5-10 acres for vegetation analysis to the specific level.

The floor (belly) mount has the advantages of: (1) ability to fly longer contiguous line coverage, (2) capability for correction of crab, tip, and tilt, (3) comfortable in-plane working conditions, and (4) ability to use wide angle (28mm) lenses. However, in contrast to side mount operations, flight line alignment and navigation during floor mount operations is almost solely the responsibility of the pilot which is not easy since he already has responsibility for aircraft operation and maintaining proper air speed and altitude.

The pending transfer of management responsibility of NPR-4 from the Department of the Navy to the Bureau of Land Management (BLM) has resulted in a significant expansion of the BLM aerial photography program on the North Slope. Contracting for BLM aerial photography must be considered a valid alternative high stage system to 35mm photography. The BLM employs a sophisticated 9x9-inch format, metric mapping camera (RC-8) in aerial photography operations and the precision, quality and larger format of this photography make it superior to 35mm photography. Moreover, it appears that the BLM contracting rates can be justified if two or more USFWS departments can contract for the same flight.

Contracting does have some inherent problems which include: (1) questionable availability of BLM aircraft for USFWS projects, (2) slow turnaround and high probability of not receiving the photography until after the field season, and (3) high contracting costs per project compared to the cost of 35mm coverage. In addition, contracting for aerial photography requires a written contract to protect the purchaser from receiving poor quality photography (e.g., excessive crab, drift, scale variation) or undesirable products (e.g., laminated or unlaminated color prints). Avery and Meyer (1962) provide useful information for developing a contract.

Colville River Delta Bird Census

Seventeen bird species were identified in the aerial survey flown on June 27. Observations made from the ground on July 19-20 verified aerial observations except the Common Loon and Snow Goose. The Yellow-billed Loon, Golden Eagle, Long-tailed Jaeger, Pomarine Jaeger and Willow Ptarmigan observed on the ground were not seen in the aerial survey. Jaeger species were difficult to distinguish from the air because of their similar characteristics. Kessel and Cade (1958) did not list the Common Loon for the Colville River Delta, but did report that the Yellow-billed Loon was common. It is possible that the Common Loon observed in the aerial census was a Yellow-billed Loon, but Kessel (personal communication) stated that Common Loons occur on the Colville River.

A comparison of the abundance of bird species found on the Colville River Delta and data gathered earlier at Storkersen Point (Bergman et al. 1976) reveals a greater species diversity in the Colville area with larger numbers of brant, eiders and swans, and the presence of the Yellow-billed Loon and Sabine's Gull not found breeding farther east. Haddock and Evans (1975) determined bird densities by fixed-wing aerial transects on the Colville River Delta in 1972. They found much higher densities of loons, swans, geese and gulls and fewer shorebirds, ducks and jaegers than in other Arctic Slope areas.

RECOMMENDATIONS

Aerial Photography

<u>Two stage remote sensing system</u>.--(1) Select concrete areas with defined boundaries at both Teshekpuk Lake and Meade River. Areas should probably be no larger than 100 square miles, (2) obtain complete small

scale coverage of these areas either with 35mm photography compiled into a mosaic or with conventional 9x9-inch color aerial photography contracted from the Bureau of Land Management. The scale selected will depend on the size of the area selected and the capabilities of the pilot, but scales of 1:25000-1:70000 for 35mm coverage and 1:20000-1:40000 for 9x9-inch coverage should be adequate and (3) within the study area establish a low stage system of small (5 acre) vegetation plots. These may either be established statistically as a random sample similar to that used on the Colville River Delta or preselected in key vegetation areas. Vegetation plots should be flown with 35mm photography at a scale of 1:6000 or larger.

Films/filters.--(1) Kodacolor II is designed for inexpensive development of color prints and, therefore, should be employed for 35mm high stage coverage and the subsequent mosaic construction. (2) Vegetation plots should be flown with color infrared film (either Type 2236 or Type 2443) because of the capability of the CIR to differentiate both *Arctophila fulva* from *Carex aquatilis* and *Arctophila fulva* from open water and (3) The 1A (haze) filter for color photography and the Wratten 12 (yellow) filter for CIR photography should continue to be used. But tests should be run using a Wratten 15 (orange) filter as a subsitute for the Wratten 12.

Methods.--Continue to follow procedures established for flight planning, photography cataloguing and storage, and mapping (Meyer 1973).

Time of photography.--Overflights for mosaic compilation may be conducted throughout the field season, but overflights for vegetation analysis ideally should be conducted during the first two weeks of August.

Aircraft procurement.--(1) It is recommended that an aircraft be contracted on a priority basis during the first two weeks of August. This will enable personnel to take advantage of every clear day during peak vegetation development, (2) side mount operations employing local aircraft should be adequate for photographing vegetation plots. For example, Helmerick's aircraft could be used on the Colville River Delta and (3) if 35mm contiguous line coverage of study areas is to be undertaken, an experienced photo pilot and aircraft equipped with a camera port should be obtained. As a possible source, the Naval Arctic Research Laboratory at Barrow maintains a Cessna 180 equipped with a camera port, a sophisticated vertical camer mount, and experienced photo pilot. The contracting rates are reasonable ($85/hour).

Field checking.--Because vegetation plot area flights will necessarily be conducted near the end of the field season, photography will not be available for field checking during most of the field season. Therefore, documentation by field notes and sketch mapping should be completed in as many of the vegetation plots as possible. Following exposure and processing 35mm photography should be analyzed and compared with field notes. Selected vegetation plots exhibiting confusing color-signature correlations or representative vegetation types should then be field checked using 35mm photography. It is recommended that 3x5-inch print enlargements be obtained of each vegetation plot.

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Appendix A. Synopsis of Aerial Photography Overflights for 1976

Date	Location	Mount	Film/Filter	Scale	Roll #	Shutter Speed	Lens (mm)	Purpose
6/26/76	Point Storkersen	Side	Kodacolor II/1A Ektachrome X/1A CIR-Type 2443/12	1:25000 1:6000 1:6000	A B Camera malfunction	1/500 sec	50	Camera Equipment Test
7/28/76	Phalarope Lake Big Lake	Side	Ektachrome X/1A CIR-Type 2236/12 Ektachrome X/1A CIR-Type 2236/12	1:12000 1:12000	1,2	1/500 sec	50	Film/Filter/Scale Test
7/28/76	Phalarope Lake Big Lake	Side	Ektachrome X/1A CIR-Type 2236/12 Ektachrome X/1A CIR-Type 2236/12	1:6000 1:6000	3,4	1/500 sec	50	Film/Filter/Scale Test
7/28/76	Phalarope Lake Big Lake	Side	Ektachrome X/1A CIR-Type 2236/12 Ektachrome X/1A	1:3000 1:3000	5,6 7	1/500 sec	50	Film/Filter/Scale Test
7/30/76	Colville River Delta	Side	Ektachrome X/1A CIR 2443/12	1:12000 1:12000	8 9	1/500 sec	50	Helmericks Island Bird Sanctuary
7/31/76	Phalarope Lake Loon Lake	Bottom (Belly)	Ektachrome X/1A	1:12000	10	1/500 sec	50	Belly mount test
8/1/76	Point Storkersen	Bottom (Belly)	Kodacolor II/1A Ektachrome X/1A	1:25000 1:25000	11,12,13,14 15	1/500 sec	50	Complete photo coverage of Point Storkersen
8/3/76	Point Storkersen	Side	Ektachrome X/1A	1:25000	16	1/500 sec	50	Bridge coverage gaps from previous overflights
8/3/76	Point Storkersen	Side	CIR 2443/12	1:25000	17	1/500 sec	50	Film/Filter Test
8/8/76	Colville River Delta	Side	Ektachrome X/1A	1:12000	18-25	1/500 sec	50	Coverage of 31 Photo Plots

Lo lon the

Ground ____ Aerial ____ Ground speed ____ Altitude ____

Transect										
Species	Pr	Pr	Pr	Pr	Pr	Pr	Pr	Pr	Pr	Pr
Arctic loon										
Red-throated loon										
Whistling swan										
Black brant										
White-fronted goose										
Pintail										
King eider										
Spectacled eider										
Oldsquaw										
American golden plover										
Black-bellied plover										
Ruddy turnstone										
Parasitic jaeger										
Long-tailed jaeger										
Glaucous gull										