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REGISTRATION VERIFICATION OF SEA/AR FIELDS

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16. Abstract

Field delineation for 20 SEA/AR sites, 1979 crop year, were entered into the BBN data base. The registration of these fields were verified using single-channel grey-scale computer printout maps of Landsat data taken over the sites. This paper documents and evaluates this method of field registration verification.

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REGISTRATION VERIFICATION OF SEA/AR FIELDS

Job Order 72-466

This report describes the activities in the verification of the registration of the SEA/AR fields.

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CONTENTS

1. INTRODUCTION

The twenty LACIE sample segments listed below were designated SEA/AR* sites for crop year 1979. Within these sites, fields of wheat were selected for intensive collection of agronomic data; field selection provides sampling of winter wheat, spring wheat and durum wheat.

sample segment number		location
1	946	Morrow, Oregon
2	947	Sherman, Oregon
3	948	Umatello, Oregon
4	949	Wilbarger, Texas
5	950	Randall, Texas
6	994	Banner, Nebraska
7	995	Keith, Nebraska
8	996	Washington, Colorado
9	997	Greeley, Kansas
10	998	Jewel, Kansas
11	999	Grant, Oklahoma
12	1465	Nelson, North Dakota
13	1471	Wells, North Dakota
14	1540	Richland, Montana
15	1577	Sheridan, North Dakota
16	1627	McKenzie, North Dakota
17	1628	McLean, North Dakota
18	1653	Burleigh, North Dakota
19	1943	Roosevelt, Montana
20	1988	Finney, Kansas

For this task, grey scale computer printouts of channel 2 and 4 were acquired from the Research Division of the Economic and Statistical Service, U.S.D.A., Washington D.C. A field delineation for all fields in the SEA areas had been

*Science and Education Administration, Agricultural Research.

entered into the Bolt, Beranek and Newman (BBN) data base. A field overlay scaled to the grey scale maps was obtained from this source. The purpose of this task was to verify the registration of the SEA area on the field overlay to the field structure evident in the single channel grey scale computer printouts for each site on each acquisition date. The specific requirements of the task were:

1. the coordinates of a registration point, usually the upper left corner of the overlay, were to be determined to ½ pixel tolerance on each channel grey scale.
2. a set of coordinates acceptable for common use of both channels was to be defined for each acquisition.
3. the amount of change from the nominal coordinates listed on the overlay was to be listed.
4. coordinates of the SEA area and field were to be listed as determined from LACIE production film converter (PFC) products and from the overlay. Coordinates for the field, interior pixels only, were to be defined.
5. the items above were to be presented in chart form

The procedure followed for registration verification is presented in section 2. Section 3 consists of charts for each of the SEA/AR sites; these charts are as defined in the requirements. The task is discussed in section 4 and a recommendation for future verification of the registration of computer entry fields with LANDSAT data is given in section 5.

2. PROCEDURE

As a preliminary to processing, reference packets were established for each of the SEA/AR sites. These packets contain the following: 1) maps, 2) statistical material on cropping practices (when available) for the site, 3) LACIE film product 1 for the segment. The film products are in the packet for reference but are substandard. Problems with the production film converter (PFC) prevented generation of good quality film products at the time of this task so imagery from the segment analyst packets was used for this study.

The possibility of increasing the acquisition coverage for the site was assessed. Acquisitions available on the Early Warning tapes were compared with those available elsewhere at Johnson Space Center (JSC). The feasibility of ordering supplementary acquisition coverage in the form of full frame imagery was also assessed. Since this task was limited to verifying the registration of the available grey scale maps, additional acquisitions were not ordered as part of the task. However, additional acquisitions available at JSC are listed on the charts of section 3.

For each SEA/AR site

1) Segment location was plotted on maps of scale 1:1,000,000 and 1:625,000.
2) Imagery was mounted and the SEA field and area was plotted on a clear plastic overlay for use with these PFC products. This overlay, coded to spatial features, permited location of the SEA field regardless of misregistration between acquisitions. It was used to aid in field location on the grey scale. Reference for the overlay was to the aircraft photography available for each site except sample segment 1628.
3) Available acquisitions were compared as on the Early Warning tapes and the film products in the LACIE analyst packets. Data quality was noted and relevant agricultural stages recorded.
4) On the grey scale, the reference point at the corner of the overlay was placed at the midpoint of the symbol at the nominal line, pixel location.

Using the film product overlay as an aid, the overlay was aligned as closely as possible to the field structure evident on the grey scale maps. Reference point coordinates were noted to the ½ pixel.

5) Reexamination of the overlay-field structure match was done and a set of coordinates common to both channels of each acquisition was defined.
6) Change from the nominal registration of the overlay was calculated for use with the BBN data base entries.
7) The charts of section 3 were compiled.

3. CHARTS

For each SEA/AR site, the following items are listed in charts 1 to 20.

- Sample segment number (LACIE) and location
- Agronomic factors and any special problems encountered in processing the segment.
- SEA area coordinates *extracted from film products. If registration is not consistent, sets of coordinates are listed for each registration.
- SEA area coordinates determined from the overlay
- SEA field coordinates extracted from film products. As with the area coordinates, coordinates are listed for each registration
- SEA field coordinates determined from the overlay
- Interior definition (no borders) for the SEA field
- SEA search area coordinates as on the overlay
- Coordinates of the overlay reference point
- A table which presents these items

  Column 1 "date": This is the acquisition date available from the Early Warning tapes and from the LACIE analyst packets, month/day format. For the grey scale printout acquisitions, the date as given on the printout is listed.

  Column 2, "point": This lists the point designation given on each grey scale printout.

  Column 3 "coordinates ch. 2, ch. 4": This gives the coordinates reconciled between the channels for the overlay reference point.

  Column 4 "change": This is the calculated change in reference point coordinates from the nominal position listed above. Direction is indicated as follows: "+" ↓, "-" ↑ (line); "+" →, "-" ← (pixel)

  *All coordinates are given (line, pixel)

Column 5 "comments": Comments on such factors as data quality as presented in th's area.

CHART 1

s.s. 946 MORROW, OREGON

- SEA area only - no field specified
- Fields are large; SEA area covers almost entire segment

SEA area coordinates from film products:

(32,20), (22,80), (15,193), (68,188), (115,25)

from overlay: (33,20), (22,79), (15,188), (67,187), (113,21)

SEA search area coordinates as on overlay:

(14,18), (14,189), (114,189), (114,18)

(14,18) is reference point

date	point	coordinates ch. 2/ch. 4	change	comments
3/14(Mar1)	2002	14.0, 20.0	0.0, +2.0	
3/22	-			
3/23(Mar2)	2003	14.5, 18.0	+0.5, 0.0	
4/5	-			20% cloud cover
5/7(May)	2004	14.0, 18.0	0.0, 0.0	clouds
5/24(May2)	2005	14.0, 19.5	0.0, +1.5	small clouds
5/25(May2)	2006	14.5, 18.5	+0.5, +0.5	
6/2(Jun)	2007	14.0, 18.0	0.0, 0.0	grey scale and imagery banded
6/3(Jun)	2008	14.0, 18.5	0.0, +0.5	grey scale banded
6/11(Jun1)	2009	14.5, 18.0	+0.5, 0.0	
6/21(Jun2)	2010	14.5, 19.0	+0.5, +1.0	
6/29(Jun2)	2011	14.5, 18.5	+0.5, +0.5	
7/17(Jul1)	2012	14.5, 18.0	+0.5, 0.0	
7/26	2013	14.0, 17.5	0.0, -0.5	map/overlay skew

CHART 1 CONTINUED

date	point	coordinates	change	comments
7/27(Jul2)	2014	14.5, 18.0	+0.5, 0.0	
9/10	-			
9/27	-			
9/28	-			
10/6	-			
10/15(Oct1)	2015	14.0, 18.0	0.0, 0.0	60% clouds

CHART 2

ss.947 SHERMAN, OREGON

- SEA area only - no field specified

SEA area coordinates from film products:
(28,30), (12,140), (20,158), (50,130), (81,100), (90,42)'
from overlay: (29,33), (15,119), (46,138), (82,95), (89,47)

SEA search area coordinates as on overlay:
(14,30), (14,131), (90,131), (90,30)
(14,30) is reference point

date	point	coordinates ch2/ch4	change	comments
3/14(Mar1)	2016	13.5, 29.5	-0.5, -0.5	
3/23(Mar2)	2017	14.0, 30.0	0.0, 0.0	
4/19(Apr1)	2018	14.0, 29.5	0.0, -0.5	cloud
4/20(Apr2)	2019	14.0, 28.0	0.0, -2.0	haze,2 clouds
4/29(Apr2)	2020	13.5, 29.5	-0.5, -0.5	cloud shadow imagery banded
5/8(May)	2021	mislocated		
5/25(May2)	2022	14.0, 29.0	0.0, -1.0	
6/3 (Jun)	2023	13.5, 30.0	-0.5, 0.0	
6/21(Jun2)	2024	13.5, 29.5	-0.5, -0.5	
6/22(Jun2)	2025	13.5, 30.0	-0.5, 0.0	
7/18(Jul1)	2026	14.0, 28.5	0.0, -1.5	
7/19(Jul1)	2027	13.5, 29.5	-0.5, -0.5	
7/27(Jul2)	2028	13.5, 28.5	-0.5, -1.5	haze
8/5	-			
8/6(Aug)	2029	14.0, 29.5	0.0, -0.5	

CHART 2 CONTINUE

date	point	coordinates	change	comments
9/10	-			
9/28	-			
9/29	-			
10/8	-			
10/17(Oct1)	2030	14.0, 30.0	0.0, 0.0	
10/26(Oct2)	2031	coordinates cannot be determined, 100% cloud cover		

CHART 3

s.s. 948 UMATILLO OREGON

- Winter wheat area, large fields
- SEA area is large; 4 grey scales are printed for each channel

SEA area coordinates:

Irregular outline covering almost entire segment

SEA field coordinates from film products:

(64,73), (62,86), (82,93), (83,80)

from overlay: (64,73), (62,87), (82,95), (83,81)
interior definition of field: (66,76), (65,85), (80,92), (82,83)

SEA search area coordinates as on overlay:

(6,18), (6,196), (117,196), (117,18)

(6,18), is reference point

date	point	coordinates ch2/ch4	change	comment
2/23(Feb2)	2033	6.5, 19.0	+0.5, +1.0	snow
3/12(Mar1)	2034	7.0, 20	+1.0, +2.0	
6/28				
8/3(Aug)	2035	6.0, 16.5	0.0, -1.5	
11/10(Nov1)	2036	6.0, 18.0	0.0, 0.0	

CHART 4

s.s. 949 WILBARGER, TEXAS

- Winter wheat area, a little cotton
- SEA field appears fallow in crop year 1980 so final acquisition listed for 1979 is 9/10
- The coordinates listed on the overlay for the search area are not correct for the imagery, the grey maps, or aircraft photography.
- Overlay seems to be sized correctly according to the grey map, but does not line up with the grey map.

SEA area coordinates from film products:
(59,50), (32,126), (50,149), (68,90), (87,113), (95,78)
from overlay: (73,55), (49,130), (65,143), (82,94), (98,106), (107,82)

SEA field coordinates from film products:
(35,89), (33,97), (41,104), (44,94)
from overlay: (51,93), (48,102), (56,108), (59,98)

interior field definition: (36,90), (34,97), (40,92), (41,95)

SEA search area coordinates as on overlay
(47,54), (47,143), (107,143), (107,54)
(47,54) is reference point relocated to (33,50)

date	point	coordinates ch2/ch4	change	comments
3/14(Mar1)	1008	32.5, 50.5	-14.5, -3.5	
4/2(Apr)	1009	32.5, 50.5	-14.5, -3.5	haze
4/29(Apr2)	1010	mislocated		
5/7(May)	1011	32.0, 48.5	-15.0, -5.5	
5/8(May)	1012	33.0, 50.0	-14.0, -4.0	
5/16(May1)	1013	32.5, 50.5	-14.5, -3.5	
5/26(May2)	1014	33.0, 51.0	-14.0, -3.0	10% haze

CHART 4 (Continued)

date	point	coordinates ch. 2/ch 4	change	comments
6/12(Jun1)	1015	33.0, 50.0	-14.0, -4.0	
6/13(Jun1)	1016	33.0, 49.5	-14.0, -4.5	
7/1(Jul)	1017	33.5, 50.5	-13.5, -3.5	
7/28(Jul2)	1018	32.5, 49.5	-14.5, -4.5	
8/5(Aug)	1019	32.5, 49.5	-14.5, -4.5	
8/24(Aug2)	1020	32.5, 48.5	-14.5, -5.5	
9/10(Sep1)	1021	33.0, 50.0	-14.0, -4.0	Imagery N.A.

CHART 5

s.s 950 RANDALL, TEXAS

- Winter wheat area, some sorghum
- Only 2 acquisitions have grey scale computer printouts. Other acquisitions are either completely mislocated or grey scale was not provided
- The SEA/AR field is very small so an interior field definition is not given.

SEA area coordinates from film products:

(70,100), (63,153), (104,169), (112,93)

from overlay: (70,97), (62,151), (102,164), (112,99)

SEA field coordinates from film products:

(85,75), (84,80), (87,82), (88,76)

from overlay: (84,73), (83,77), (87,79), (88,74)

SEA search area coordinates as on overlay:

(61,72), (61,165), (112,165), (112,72)

(61,72) is reference point

date	point	coordinates ch. 2/ch 4	change	comments
2/27(Feb2)	1003	62.0, 73.5	+1.0, +1.5	much of grey scale missing.
5/10(May1)	1003	62.0, 75.0	+1.0, +3.0	These are duplicates they should be anno-
9/22(May 1)	1004	62.0, 75.0	+1.0, +3.0	tated "May 1, 1004"

CHART 6

s.s 994 BANNER, NEBRASKA

- Winter wheat area - some hay is grown
- SEA/AR field is a series of strip/fallow field (strips are not visible on the imagery) and "within field" coordinates could not be defined.
- Registration is different between 4/7 and 8/2, 8/11

SEA area coordinates from film products:

for [4/7]: (38,50), (19,160), (40,170), (58,58)

for [8/2, 8/11]: (25,60), (16,170), (27,180), (40,69)

from overlay: (39,50), (19,161), (41,169), (57,57)

SEA field coordinates from film products

for [9097]: (82,53), (79,63), (67,88), (90,68)

for [9214, 9223]: (68,63), (67,73), (75,77), (76,68)

from overlay: (81,50), (79,64), (89,67), (91,53)

SEA search area coordinates as on overlay:

(20,48), (20,168), (91,168), (91,48)

(20,168), upper right corner, is reference point

date	point	coordinates ch. 2/ch 4	change	comments
4/7(Apr)	2057	20.5, 167.5	+0.5, -0.5	Snow
8/2(Aug)	2058	6, 179.5	-14, +11.5	SEA field off grey scale
8/11(Aug1)	2059	6, 180.5	-14, +12.5	SEA field off grey scale

CHART 7

s.s 995 KEITH NEBRASKA

- Winter wheat area - some corn is grown
- Misregistration is extreme for this segment between dates [4/5, 5/11, 5/28] and [7/21, 7/22, 7/30]. However the SEA field is still on the segment.

SEA area coordinates from film products:

for dates [4/5, 5/11, 5/28]: (53,10), (44,65), (84,80) (90,26)
for dates [7/21, 7/22, 7/30] (off segment), (81,38), (off segment), (off segment)
from overlay: (53,10), (45,64), (85,80), (93,27)

SEA field coordinates from film products:

for dates [4/5, 5/11, 5/28]: (68,58), (65,70), (74,74), (75,61)
for dates [7/21, 7/22, 7/30]: (106,30), (103,43), (112,47), (115,34)
from overlay: (67,58), (65,72), (75,76), (78,56)
interior definition of field: (69,60), (65,70), (72,72), (74,72)

SEA search area coordinates as on overlay:

Point (44,80) (upper right corner)is used as the reference.

date	point	coordinates ch. 2/ch 4	change	comments
4/5(Apr)	2060	(44,80)	0.0, 0.0	
5/11(May1)	2061	(44,-78.5)	0.0, -1.5	
5/28(May2)	2062	(43,5,80)	-0.5, 0.0	
7/21(Jul2)	2063	(82,52)	+38.0, -28.0	grey scale incomplete
7/22(Jul2)	2064	(82,53)	+38.0, -27.0	25% clouds grey scale incomplete
7/30(Jul3)	2065	(81.5,52)	+37.5, -28.0	grey scale incomplete

CHART 8

s.s 996 WASHINGTON, COLORADO

- Winter wheat area
- Misregistration is a problem. Field definition on overlay is for dates [2/28, 4/5, 4/6, 4/23, 5/11]. Registration is skew and offset for dates [7/23, 8/1] but SEA fields are still on the image
- Acquisition coverage is poor. Full frame imagery should be available for additional dates 6/26, 10/17, 11/2.
- Since SEA/AR field are strip fields, interior coordinates were not defined.

SEA area coordinates from film products:

for dates [2/28, 4/5, 4/6, 4/23, 5/11]: (22,90), (16,144), (55,161), (63,105)

for dates [7/23, 8/1]: (27,118), (20,172), (60,188), (68,131)

from overlay: (24,91), (15,146), (52,176), (63,107)

SEA field coordinates from film products:

for dates [2/28, 4/5, 4/6, 4/23, 5/11] 1: (52,103), (49,128), (50,128), 54,104)

2: (58,105), (55,130) (57,131), (60,106)

for dates [7/23, 8/1] 1: (57,128), (54,153), (56,154), (59,129)

2: (62,129), (59,155), (61,155), (64,130)

from overlay 1: (54,103), (50,131), (52,132), (56,104)

2: (58,105), (55,132), (57,134), (61,106)

SEA search area coordinates as on overlay:

[2/28, 4/5, 4/6, 4/23, 5/11]: (13,90), (13,176), (64,176), (64,90)

(13,90) is reference point.

date	point	coordinates ch. 2/ch 4	change	comments
2/28(Feb2)	2049	12.0, 90.5	-1.0, +0.5	These acquisitions are available from JSC. May not be on the Early Warning tape although grey scale is available
4/5(Apr)	2050	12.0, 91.0	-1.0, +1.0	

CHART 8 (Continued)

date	point	coordinates ch. 2/ch 4	change	comments
4/6(Apr)	2051	12.5, 91.0	-0.5, +1.0	
4/23(Apr)	2052	12.0, 90.0	-1.0, 0.0	
5/11(May1)	2053	12.0, 90.5	-1.0, +0.5	
7/23(Jul2)	2054	17.0, 114.5	+4.0, +24.5	
8/1(Aug)	2055	18.0, 115.5	+5.0, +25.5	

CHART 9

s.s 997 GREELEY, KANSAS

No 1979 acquisitions

CHART 10

s.s. 998 JEWEL, KANSAS

- Winter wheat area, hay and sorghum also grown
- There is only one date - in March - for this site.

SEA area coordinates from film products: (50,34),(49,59),
(30,51), (26,79), (85,102), (89,74), (70,67) (73,42)
from overlay: (54,35), (50,61), (30,54), (27,81), (85,102), (89,75)

SEA field coordinates from film products:
(51,49), (49,59), (57,60), (57,53)
from overlay: (52,50), (50,60), (58,64), (57,55)

interior SEA field definition: (52,51) (51,58), (56,60), (56,54)

SEA search area coordinates as on overlay:
(25,34), (25,102), (90,102), (90,34)
(25,34) is reference point

date	point	coordinates ch. 2/ch 4	change	comments
3/15(Mar1)	2072	25.0, 34.0	0.0, 0.0	

CHART 11

s.s 999 GRANT, OKLAHOMA

- Winter wheat is the principal crop - some hay is grown
- Looks like there is a grass waterway in the SEA field

SEA area coordinates from film products:

(20,110), (13,162), (53,177), (60,123)

from overlay: (21,112), (12,164), (50,178), (59,125)

SEA field coordinates from film products

(40,117), (39,125), (50,125), (50,120)

from overlay: (40,118), (39,125), (48,127), (50,121)

interior field definition: (41,117), (40,123), (48,124), (49,120)

SEA search area coordinates as on overlay:

(11,110), (11,179), (60,179), (60,110)

(11,110) is the reference point

date	point	coordinates ch. 2/ch 4	change	comments
12/14(Dec1)	2087	11, 110.5	0, +0.5	
3/14(Mar1)	2088	10.5, 110.5	-0.5, +0.5	
5/7(May)	2089	10.5, 111.0	-0.5, +1.0	
5/25(May2)	2090	11.0, 109.5	0.0, -0.5	

CHART 12

s.s 1465 NELSON, N. DAKOTA

- Summer wheat and durum wheat region. Barley, flax and oats are also grown
- Diagonal stream through SEA field

SEA area coordinates from film products:
(10,89), (1, 105), (40,121), (49,69)
from overlay: (12,54), (1,106), (41,123), (52,72)

SEA field coordinate from film products:
(4,90), (2,99), (12,104), (14,95)
from overlay: (4,92), (2,102), (13,107), (14,97)

interior field definition: (5,91), (4,98), (11,99), (12,95)

SEA search area coordinates as on overlay:
(0,53), (0,123), (52,123), (52,53)
(0,53) is reference point

date	point	coordinates ch. 2/ch 4	change	comments
4/22(Apr2)	1049	-0.5, 53.0	-0.5, 0.0	
5/28(May2)	1050	0.0, 52.0	0.0, -1.0	
6/15(Jun1)	1051	-0.5, 51.5	-0.5, -1.5	
6/16(Jun1)	1052	-1.0, 52.0	-1.0, -1.0	haze
7/21(Jul2)	1053	-0.5, 51.5	-0.5, -1.5	
7/22(Jul2)	1054	0.0, 51.5	0.0, -1.5	skew
8/8(Aug)	1055	0.0, 51.5	0.0, -1.5	
8/9(Aug)	1056	0.0, 53.0	0.0, 0.0	15% cloud, shadow
8/17(Aug1)	1057	-0.5, 52.0	-0.5, -1.0	
8/18	-			
8/27(Aug2)	1058	0.0, 52.0	0.0, -1.0	
9/5(Sep)	1059	0.0, 53.0	0.0, 0.0	
9/23(Sep2)	1060	0.0, 51.5	0.0, -1.5	

CHART 12 (Continued)

date	point	coordinates ch. 2/ch 4	change	comments
10/1(Oct)	1061	-0.5, 51.5	-0.5, -1.5	
10/28(Oct2)	1062	-1.0, 53.0	-1.0, 0.0	haze, clouds

CHART 13

s.s 1471 WELLS, N. DAKOTA

- segment is misplotted on aircraft photography.
- overlay, aircraft photography are mislocated with respect to grey scale and imagery
- SEA/AR field is small, hence interior field definition omitted
- spring wheat, durum, barley and flax are grown in the area
- some of SEA area is missing from grey scale map

SEA area coordinates from film products:
(39,62), (31,117), (70,132), (79,79)
from overlay: (57,23), (15,140), (53,156), (63,102)

SEA field coordinates from film products: (13,116), (10,138), (12,139), (15,118)
from overlay: (-5,139), (-8,160), (-6,162), (-3,141)

SEA search area coordinates as on overlay:
(-9,85), (-9,163), (63,163), (63,85)
(-9, 85) is reference point relocated to (7, 61)

date	point	coordinates ch. 2/ch 4	change	comments
4/28	-	no gray scale		clouds and shadow 30% of scene
6/16(Jun1)	1045	7.5, 64.5	+16.5, -20.5	clouds and shadow 40% of scene
7/22(Jun2)	1046	7.5, 62.0	+16.5, -23.0	
8/9(Aug)	1047	7.5, 62.0	+16.5, -23.0	20% clouds
8/27(Aug2)	1048	7.5, 63.5	+16.5, -21.5	

CHART 14

1540 RICHLAND, MONTANA

- spring wheat area
- SEA/AR field is only partially located within segment. No interior field coordinates were defined
- grey scale channel computer printouts were not available for this segment

  NOTE: Registration was done using film products on this segment since grey scale maps were not available.

SEA area coordinates from film products:

(37,73), (32,100), (114,133), (117,103)

from overlay: (38,74), (32,102), (112,133), (117,106)

SEA field coordinates from film products:

(1,139), (4,140), (3,147), (1,146)

from overlay: (1,138), (4,139), (3,147), (1,146)

SEA search area coordinates as on overlay: (31,73), (31,134), (117,134), (117,73)

(31,73) is reference point

(32,100), upper right corner of SEA area, was used for reference working with film products

date	point	coordinates ch. 2/ch 4	change	comments
5/15		33, 101	+1.0, +1.0	
5/23		32. 100	0.0, 0.0	
5/24		33, 100	+1.0, 0.0	
6/10		33, 100	+1.0, 0.0	
6/11		32, 100	0.0, 0.0	
6/20		32, 100	0.0, 0.0	clouds
6/28		33, 100	+1.0, 0.0	
6/29		33, 100	+1.0, 0.0	
7/25		32, 100	0.0, 0.0	
8/3		32, 100.5	0.0, 0.5	

CHART 14 (Continued)

date	point	coordinates ch. 2/ch 4	change	comments
8/4		32, 100	0.0, 0.0	
8/12		32. 100.5	0.0, +0.5	10% clouds
8/13		32, 100	0.0, 0.0	haze
8/30		32, 101	0.0, 0.0	30% clouds
9/9		32, 100	0.0, 0.0	
9/18		32.5, 100	+0.5, 0.0	

CHART 15

s.s 1577 SHERIDAN, N. DAKOTA

- spring wheat area
- SEA field is separate from the SEA area and only a small portion of the field is within the LACIE segment. No interior coordinates were defined for the partial field.

SEA area coordinates from film products:

(20,47), (11,100), (32,109), (37,81), (75,96), (80,70)

from overlay: (22,46), (12,101), (32,108), (36,81), (76,96), (80,67)

SEA field coordinates from film products:

(1,78), (1,86), (3,87), (4,77)

from overlay: (1,82), (1,89), (4,90), (5,83)

SEA search area coordinates as on overlay:

(-7,45), (-7,109), (81,109), (81,45)

(81,45), lower left corner, is used as the reference point

date	point	coordinates ch. 2/ch 4	change	comments
5/12(Mayl)	1038	80.5, 46.0	-0.5, +1.0	
8/1(Aug)	1039	80.5, 44.5	-0.5, -0.5	
8/9(Aug)	1040	mislocated	-42.0, -7.5	Mislocation seems to be about 40 pixels with reference point at
8/18	-	-	-	39, 37.5
8/27(Aug2)	1041	80.0, 46.0	-1.0, +1.0	
8/18(Aug2)	1042	80.0, 44.5	-1.0, -0.5	
9/5(Sep)	1043	79.5, 44.5	-1.5, -0.5	

CHART 16

s.s 1627 McKENZIE; N. DAKOTA

- SEA area only - no field specified
- durum, spring, a little winter wheat plus hay are grown in this area
- fields on the SEA area are strip fields
- area is very difficult to locate on the film products due to quality of film, strip fields evident only at harvest stage
- gray scale/overlay are off by ½ pixel: 57-155 extends 57.5 - 155

SEA area from film products:

(63,60), (50,141), (90,156), (93,98), (98,72)

from overlay: (64,59), (51,139), (90,154), (89,97), (94,70)

SEA search area as on overlay:

(49,57), (49,155), (100,155), (100,57), (99,101)

(49,57) is reference point

date	point	coordinates ch. 2/ch 4	change	comments
5/23(May2)	1022	48.5, 58.0	-0.5, +1.0	
6/10(Jun1)	1023	48.5, 58.5	-0.5, +1.5	
7/15(Jul2)	1024	49.0, 58.0	0.0, +1.0	
8/12(Aug1)	1025	49.0, 58.0	0.0, +1.0	clouds
8/30(Aug2)	1026	48, 58.5	-1.0, +1.5	

CHART 17

s.s 1628 McLEAN, NORTH DAKOTA

- this segment is in an area of winter wheat, spring wheat and durum wheat.
- aircraft photography was not available for this segment
- overlay with reference line, pixel location was not available
- area is strip fields

This segment was not processed since the SEA/AR areas could not be delineated accurately. Grey scale computer printout maps are available for the acquisitions below:

7/23 (Jul2) point 1028
8/1 (Aug) point 1029
8/28 (Aug 2) point 1030
9/6 (Sep) point 1031

CHART 18

s.s 1653 BURLEIGH, NORTH DAKOTA

- spring wheat (and durum wheat) area; barley and hay are also grown
- overlay and aircraft photography mislocated relative to imagery, gray scale
- no SEA field defined, SEA area is composed of strip fields

SEA area from film products:

(28,32), (20,86), (60,106), (70,50) area is uncertain since film products are poor quality

from overlay (21,32), (12,86), (52,100), (61,46)

SEA search area coordinates as on overlay:

(11,30), (11,101), (61,101), (61,30)

(11,30) is reference point

date	point •	coordinates ch. 2/ch 4	change	comments
5/3(May)	1032	20.0, 33,5	+9.0, +3.5	clouds
7/5(Jul)	1033	20.0, 33.5	+9.0, +3.5	clouds
7/22(Jul2)	1034	20.5, 32.0	+9.5, +2.0	incomplete grey scale
8/11(Aug)	1035	21.0, 32.0	+10.0, +2.0	incomplete grey scale
8/18	-			
8/27(Aug2)	1036	19.5, 33.5	+8.5, +3.5	
8/28(Aug2)	1037	19.0, 32.0	+8.0, +2.0	clouds

CHART 19

s.s 1943 ROOSEVELT, MONTANA

- spring wheat area, some hay and grain feed crops are grown

SEA area coordinates from film products:

(12,40), (3,94), (43,110), (52,55)

from overlay: (13,40), (3,94), (42,109), (52,56)

SEA field coordinates from film products

(47,83), (46,90), (56,93), (57,88)

from overlay: (47,83), (46,90), (56,94)

interior field definition: (48,84), (48,88), (85,90), (85,86)

SEA search area coordinates as on overlay:

(2,38), (2,110), (58,110), (58,38), (57,89)

(2,38) is the reference point

date	point	coordinates ch. 2/ch 4	change	comments
5/15(May1)	2037	1.5, 39.0	-0.5, +1.0	
5/23(May2)	2038	1.0, 38.0	-1.0, 0.0	
5/24(May2)	2039	1.5, 38.0	-0.5, 0.0	
6/10(Jun1)	2040	1.0, 38.0	-1.0, 0.0	
6/11(Jun1)	2041	2.0, 39.0	0.0, +1.0	
6/29(Jun2)	2042	1.5, 38.0	-0.5, 0.0	
8/4(Aug)	2043	1.5, 37.5	-0.5, -0.5	a few clouds, slight misregistration
8/13(Aug1)	2044	1.5, 38.5	-0.5, +0.5	
8/21	-			
9/7	-			cloud

CHART 19 (Continued)

date	point	coordinates ch. 2/ch 4	change	comments
9/8	-			
9/17(Sep1)	2045	1.0, 37.5	-1.0,-0.5	
9/18(Sep1)	2046	1.5, 38.0	-0.5, 0.0	
9/26(Sep2)	2047	0.5, 38.5	-1.5, +0.5	
10/6	-			haze
10/24(Oct2)	2048	2.0, 39.5	0.0, +1.5	

CHART 20

s.s. 1988 FINNEY, KANSAS

- winter wheat area - some hay and summer crops
- no SEA/AR fields defined: the field designated in the fall was abandoned in the spring
- there are registration - and location - problems. Acquisition 2/27 and 4/22 are mutually registered; 7/21, 7/29, 8/7, 8/8, 8/16, 9/3, 10/1 are mutually registered Acquisition 7/11 is so severly misregistered it cannot be located on the segment. For several of the acquisitions a skew-adjustment would have improved overlay/grey scale correspondence.

SEA area coordinates from film products:

for [2/27, 4/22]: (42,9), (34,63), (74,78), (78,50), (108,60), (111,34)

for [7/21, 7/29, 8/7, 8/8, 8/16, 9/3, 10/1]: (27,15), (17,70), (57,84), (60,56), (90,65), (93,40)

from overlay: (42,9), (34,63), (75,77), (79,51), (109,61), (112,35)

SEA search area coordinates as on overlay:

(33,7), (33,78), (112,78), (112,7)

point (33,7), upper left corner is taken as the reference point

date	point	coordinates ch. 2/ch 4	change	comments
2/27(Feb2)	2073	33.0, 5.5	0, -1.5	
4/22(Apr2)	2074	33.5, 7.0	+0.5, 0	
7/11(Jul1)	2075	severely mislocated - cannot use		
7/21(Jul2)	2076	16,13	-17.0, +6.0	
7/29(Jul2)	2077	16.5, 14	-16.5, +7.0	

CHART 20 (Continued)

Date	point	coordinates ch. 2/ch 4	change	comments
8/7(Aug)	2078	15.5, 12.5	-17.5, +6.5	
8/8(Aug)	2079	15.5, 12.5	-17.5, +6.5	
8/16(Aug)	2080	15.5, 13.5	-17.5, +7.5	
8/25(Aug2)	2081	16.5, 12.5	-16.5, +6.5	
9/3(Sep)	2082	15, 13	-18.0, +7.0	
9/12(Sep1)	2083	15,13	-18.0, +7.0	
9/30(Sep3)	2084	15.5, 12	-17.5, +6.0	
10/1(Oct)	2085	15.5, 13.5	-17.5, +6.5	

4. DISCUSSION

The coordinate definitions given in this task are necessarily subjective and lack precision. In LANDSAT data, the value of each pixel affects the values of adjacent pixels due to MSS sensor overlap. Hence a field border tends to be three pixels wide. In addition, field structure is appreciably weaker in single channel data than it is in a composite of several channels of data. Use of single channel grey scale printouts provides less field definition than, for example, the three channel imagery generated from LANDSAT data. Coordinate definition reflects this. Although every effort was expended to align the overlays with the grey scale maps accurately, single channel data does not contain the information to do this perfectly. It may be possible to introduce error by this method of registering fields to single channels and then aligning the results rather than registering the channels and then aligning the fields.

Reference to film product acquisition images was necessary for all segments used in this task; grey scale maps cannot be used effectively without this aid. Field delineation on aircraft photography is impossible to relate directly to a grey scale. However, aircraft photography can be correlated to film imagery using spatial features; then the coordinates available on the film products can be used to relate the image to the grey scale. Misregistration proved to be a significant problem in this task. Without the film products and film product overlay, misregistration would have prevented overlay coordinate definition for many acquisitions.

A key to the symbols used on the grey scale maps was required for this task but was not available. Such a key would have aided the correlation of fields on the grey scale to those evident on the film products. Informal information stipulated a histogram technique, acquisition specific, with "more ink" indicating lower reflectivity. Observation confirmed this for some acquisitions. The task suffered from the absence of a key to materials specified for use.

Several specific problems complicated the execution of this task.

- Three of the segments listed in section 1.0 could not be processed by the procedure of section 2.:
  1. There were no 1979 acquisitions for segment 997.
  2. The aircraft photography was not available for segment 1628 and the coordinates were not listed on the overlays available for this segment. Since the segment is composed of strip fields, the SEA area was impossible to locate without these aids.
  3. The grey scale computer printouts were not available for segment 1540. The registration between acquisitions was checked using film products only.
- SEA/AR fields were not defined for segments 946, 947, 1627, 1653, and 1988, hence SEA areas only were verified for these segments. For segments 1540 and 1577, the SEA field is only partially located within the segment. For segment 950, 994, 996, 1471 and 1627, the SEA fields are very small or are strip fields. For these seven segments, interior field coordinates could not be defined.
- Misregistration between acquisitions was a severe problem, especially in segments 994, 995, 996, and 1988. Use of film products with clear plastic overlay made coordinate definition possible in these segments.
- Segment delineation on the aircraft photography was different from segment delineation on the grey scale maps and film products for some segments. In segment 1471, this discrepancy was beneficial since the SEA field, which is off the segment according to the aircraft photography, is within the segment in the other products. Segments 1653 and 1471 are examples of the overlay and the aircraft photography misregistered with respect to the grey scale maps and the imagery. For these segments, the reference point was relocated with the aid of the film products and the clear plastic overlay.
- For s.s. 949, the coordinates given on the overlay did not match SEA area for the imagery, the grey scale maps, or the aircraft photography. The overlay was sized correctly for the grey scale map, but when the overlay

was matched to evident field structure in the upper portion of the overlay, the lower fields did not align well to field structure.

- Requirements for this task specified ½ pixel tolerance for coordinate definition. The overlay was not scaled to this tolerance. For example, in s.s. 1627, the space from pixel 59 to pixel 155 on the overlay extends from 57.5 to 155 on the grey scale. This introduced error.
- If total segment grey scales are supplied they are extremely cumbersome to use; s.s. 948 is an example. Grey scales were usually supplied for the area immediately surrounding the SEA area, hence the misregistration and segment location problems resulted in crucial areas missed, or partially missed, on the grey scale maps; s.s. 950, 994, 995, 1653 and 1988 are examples of this.
- In addition to lack of a key to the equivalence of the grey scale symbols to spectral values, notation on the grey scales was poor. As can be observed on the charts, use of date designations such as (Aug), (Aug1), (Aug2) seems somewhat random. The point reference notation. however, was reliably one-per-acquisition and sequential except for segment 950.

5. RECOMMENDATION

The use of single channel grey scale computer printouts should be avoided for the verification of field overlay registration. Use of grey scale printouts for this purpose is extremely time consuming. In addition, single channel LANDSAT data does not consistently offer sufficient evident field structure for accurate field alignment; use of single channel printouts for this purpose may introduce error to the field definition.

Use of an overlay and grey scale printout must be accompanied by a parallel system of film product images with a clear plastic field overlay; this serves to link the spatial features of the aircraft photography (the apparent source of the overlay) to a line, pixel coordinate system applicable to the grey scale maps. Further, the alignment of the final registration determined for the overlay should be verified on the terminal by display of the fields on the acquisition images.

A computer field overlay such as was supplied for this task could perhaps be verified effectively by using the image display and field overlay capabilities of the Integrated Multivariant Data Analysis and Classification system on the PDP 11-70. Any realignment of the overlay to the strong field structures usually evident in the three channel image display could be done directly on the terminal and adjustments noted. The field delineation on the aircraft photography will correlate to the image display. This alternate method should be tested.