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MMS 2003-006

ENVIRONMENTAL SENSITIVITY INDEX SHORELINE CLASSIFICATION OF THE ALASKAN BEAUFORT SEA AND CHUKCHI SEA

Prepared for:

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DISCLAIMER

This report has been reviewed by the Minerals Management Service and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Service, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

ACKNOWLEDGEMENTS

This report was prepared under contract to the Minerals Management Service, Contract No. 1435-01-00-RP-31072. Richard Newman was the MMS Contracting Officer's Technical Representative and facilitated all aspects of the work on this project. Lenny Coats, Computer Specialist with the Information Technology Division, New Orleans, Louisiana, is acknowledged for his assistance in reviewing the ESI data and loading the data into the Coastal and Offshore Resource Information System (CORIS) database. CORIS is part of the MMS Corporate Technical Information Management System (TIMS) database.

Jacqueline Michel of Research Planning, Inc. (RPI) was the overall Project Manager. At RPI, Miles O. Hayes was responsible for editing of the shoreline classification and Mark White, GIS Manager, was responsible for production of the digital shoreline classification data. Jonathan Whitlock, Vermell Pyatt, and Jessica Diimmler digitized the shoreline data. Edward H. Owens of Polaris Applied Sciences, Inc. was responsible for the initial shoreline classification and production of the overflight video products.

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LIST OF ABBREVIATIONS

CD	Compact Disk
CORIS	Coastal and Offshore Resource Information System
DVD	Digital Video Disk
ESI	Environmental Sensitivity Index
GMT	Greenwich Mean Time
GPS	Global Positioning System
ITD	Information Technology Division
MMS	Minerals Management Service
MPEG	Moving Picture Experts Group
NOAA	National Oceanic and Atmospheric Administration
ROM	Read Only Memory
RPI	Research Planning, Inc.
TIMS	Technical Information Management System
UTC	Universal Time Coordinated
USGS	U.S. Geological Survey

ENVIRONMENTAL SENSITIVITY INDEX SHORELINE CLASSIFICATION OF THE ALASKAN BEAUFORT SEA AND CHUKCHI SEA

1.0 INTRODUCTION

The objectives of the project were:

1. Classify the shorelines of the Alaskan Beaufort Sea and Chukchi Sea using the Environmental Sensitivity Index (ESI) classification scheme;
2. Create digital ESI data and incorporate the data into the Minerals Management Service (MMS) Coastal and Offshore Resource Information System (CORIS) database. CORIS is part of the MMS Corporate Technical Information Management System (TIMS) database; and
3. Create video products from the aerial video imagery obtained during the overflights.

The Beaufort Sea was mapped between the Colville River and Point Barrow in the west and between the Canning River and the Canadian border to the east. The middle section of the Beaufort Sea had recently (1994-1996) been mapped and the shoreline data were incorporated into hardcopy ESI maps and digital data produced by the National Oceanic and Atmospheric Administration (NOAA) in 1999. The Chukchi Sea was mapped from Point Barrow to Point Hope. Figure 1 shows the shoreline mapped for each area. The shoreline classification methods and final products are described in the following sections.

2.0 SHORELINE CLASSIFICATION METHODS

The shoreline classification was based on low-altitude aerial videotape surveys that were conducted on 24-28 July 2001 for the Beaufort Sea and 28-29 July 2001 for the Chukchi Sea. The field survey crew consisted of Ed Owens of Polaris Applied Sciences, Inc. and Doug Reimer of Environmental Mapping Ltd. The survey method for the Beaufort Sea included:

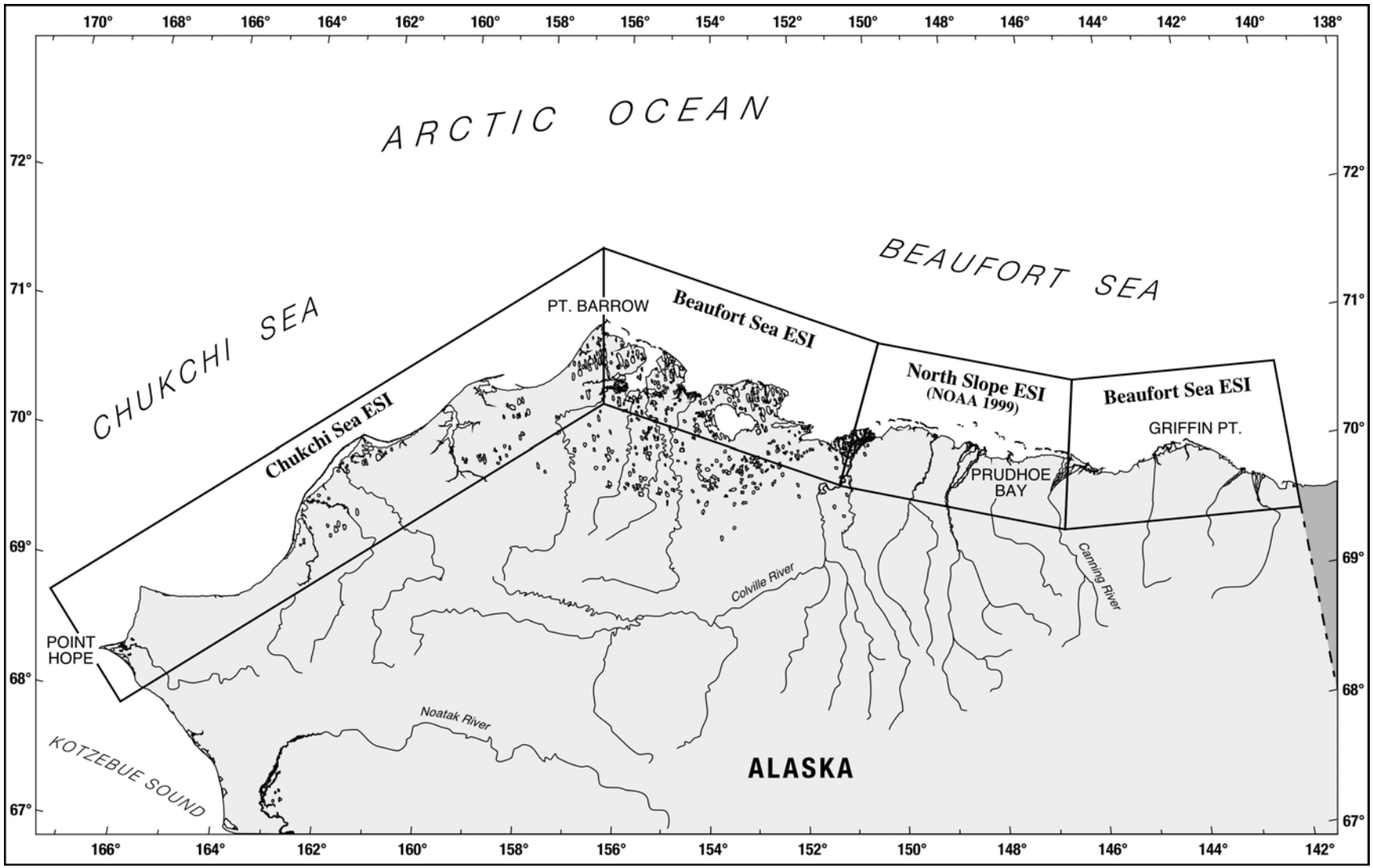


Figure 1. Areas of the Alaskan Beaufort Sea and Chukchi Sea that were mapped using the ESI shoreline classification system. Note that the segment between the Colville and Canning Rivers was previously digitized as part of the North Slope ESI maps.

- Oblique videotape imagery of the North Slope was collected from a helicopter with the window open or door removed to provide unrestricted views, at altitudes less than 100 m.
- Direct observations were recorded continuously on videotape (both picture and audio) to document the physical shore-zone character.
- Geographical positions (latitude and longitude) were recorded on the video image and simultaneously stored on the computer.
- "Ozi Explorer", a commercial navigation and data collection software package, provided real-time display of flight paths during the surveys and way-point documentation (these data also were stored on the computer).

The imagery of the Chukchi Sea coast followed exactly the same procedures but was obtained from a single-engine fixed high-wing aircraft. This type of aircraft cannot follow the shoreline as closely as a helicopter; however, the majority of the Chukchi coast is a straight shoreline so that the maneuverability provided by a helicopter was not necessary. This maneuverability was a key element for the many sections of complex shoreline that typify much of the North Slope. Barrier islands are common in both the North Slope and Chukchi Sea regions, and so the flight lines covered both the outer coast and the mainland shoreline.

The data collection system used for the aerial video surveys is an integration of individual components and software. The system was designed to provide a compact high-quality system that could be easily transported and used in any aircraft of opportunity. The general hardware components of the system are:

- Hi-8mm video camera for image collection and a safety backup video. The camera, a Sony CCD-TRV43 330x Digital Zoom, has a large number of built-in features that specifically include a 4.1 to 73.8 mm zoom lens, auto-exposure, auto-focus, and image stabilization ("Steady Shot").
- Digital video recorder for the main data collection of video imagery.
- Garmin GPS III+ for geographic location input to video system.
- Horita Converter that integrates the GPS and video data.

- Com A unit that integrates the aircraft intercom with the video recorder to record the audio commentary (on two separate channels if required).
- Portable computer that provides moving map displays and records data.

The key element of the survey is the continuous audio commentary that records a systematic description of shore-zone features, using the video image as a frame of reference. The mapping of the shore-zone character is based almost exclusively on this commentary rather than on the videotape image itself. This survey generated 9.3 hours of video footage for the North Slope coast and 7.15 hours of footage for the Chukchi Sea coast.

The video was viewed to classify the shoreline types and mark the boundaries between each shoreline segment onto 1:63,360 U.S. Geological Survey (USGS) topographic maps. For the Beaufort Sea, the primary and secondary shoreline types were entered into a database that was linked to the shoreline segment on each map. For the Chukchi Sea, the shoreline classification was marked directly on the topographic maps. Table 1 shows the ESI shoreline classification used for both mapped areas.

A digital shoreline for the two study areas was obtained from three sources: 1) 1:63,360 DLG data from the USGS published in 1999 (based on data from 1950-1997) was the primary data source; 2) 1:63,360 scale data from the State of Alaska Department of Natural Resources published in 1998; and 3) for a few areas for which no digital data were available, the shoreline was digitized from hardcopy 1:63,360 scale USGS maps. The digital data include a source ID that indicates which source was used for each shoreline segment.

The shoreline classification was digitized, following the NOAA ESI guidelines (Peterson et al. 2002). Briefly, the hardcopy maps were scanned and the digital shoreline arcs were updated with the ESI shoreline types. The shape and position of the digital shoreline was also changed to reflect field observations noted on the field maps. After the information from the field maps had been incorporated into the digital database, the now-ESI color-coded shoreline was replotted at the same scale as the original base maps. The classified shoreline plots were

Table 1. Environmental Sensitivity Index (ESI) shoreline classification used for the Beaufort Sea and Chukchi Sea.

ESI RANKING	SHORELINE DESCRIPTION
1A	Exposed rocky shores
1B	Exposed, solid man-made structures
2A	Exposed wave-cut platforms in bedrock, mud, or clay
3A	Fine- to medium-grained sand beaches
3C	Tundra cliffs
4	Coarse-grained sand beaches
5	Mixed sand and gravel beaches
6A	Gravel beaches
7	Exposed tidal flats
8A	Sheltered scarps in bedrock, mud, or clay
8B	Sheltered, solid man-made structures
8E	Peat shorelines
9A	Sheltered tidal flats
10A	Salt- and brackish-water marshes
10E	Inundated low-lying tundra

then compared by an experienced geologist to the original field-annotated base maps, and any errors in shoreline attributes as recorded in the spatial database were corrected.

3.0 PROJECT DELIVERABLES

3.1 ESI Digital Data

Digital ESI shoreline data for the Beaufort Sea and the Chukchi Sea were developed from 1:63,360 USGS DLG data, 1:63,360 Alaska Department of Natural Resources digital shoreline data, and heads-up digitization of 1:63,360 USGS topographic quadrangles. These digital data sets were merged into a single data layer for the entire study area from the Canadian Border west to Point Hope. The study area excludes a segment of shoreline along the Beaufort Sea from the Canning River west to the Colville River. This shoreline segment, referred to as the North Slope ESI on Figure 1, was mapped under a separate contract with NOAA and published with the hardcopy and digital ESI atlas for the North Slope in 1999. The North Slope ESI data can be imported into CORIS in their current format.

The Beaufort Sea and Chukchi Sea ESI shoreline data were developed for integration into the TIMS CORIS database. To make these data compatible with CORIS, we followed the NOAA ESI guidelines (Petersen et al. 2002), which have become an industry standard for the development of ESI data sets. The vector arcs and complex polygons were updated with valid attributes as specified in the guidelines. These data were subjected to a stringent, multi-stage quality assurance process that included verification of attribute accuracy, checks for missing or duplicate data, and topological consistencies. The horizontal positional accuracy of the ESI data set reflects that of the pre-existing digital data sources used to develop the final data. The 1:63,360 USGS topographic quadrangles should conform to the National Map Accuracy Standards at scales of 1:63,360. The minimum mapping unit of the actual shoreline segments is estimated to 50 meters when mapping is conducted using 1:24,000 scale hardcopy field maps. Field verification has shown that the absolute positional accuracy of breaks between shoreline ESI types with a 95-percent error bound is approximately 58 meters (Petersen et al. 2002).

The Hydro data set, an additional deliverable not requested by MMS, was developed from the same pre-existing digital data as the ESI and was subjected to the same multi-stage

quality assurance process. These data were developed following the NOAA ESI guidelines (Petersen et al. 2002), making the data compatible with the CORIS database.

The ESI and Hydro data sets and metadata were forwarded to Lenny Coats, Computer Specialist with MMS, Information Technology Division (ITD), for final review. The ITD was able to successfully load the ESI and Hydro data sets into the TIMS Environmental CORIS database.

The hardcopy field maps were also delivered to MMS for archiving and referral.

3.2 Overflight Video Products

The aerial video survey resulted in 11 production videotapes. The imagery for the Beaufort Sea was produced as a set of 11 Movie DVD disks and 11 digital VHS tapes with a flight log book in hardcopy and on CD. The field imagery was edited to add introductory titles and transit breaks only; they were not edited for content. Table 2 shows the videotape logs for the Beaufort Sea video products.

The videotape formats used for the survey were:

Original Camera Field Tapes	-	Digital Me (Clean image / safety field backup)
Original Recorder Field Tapes	-	Digital Me (Audio / GPS data)
Copy masters	-	Digital Me (Titles / computer edit files)
Production copies	-	VHS/SVHS
	-	Movie DVD disk
	-	MPEG 1 DVD-ROM digital files (2500 bits/sec)
	-	MPEG 2 DVD-ROM digital files (8000 bits/sec)

Table 2. Videotape log for the 11 tapes/DVDs for the Beaufort Sea mapping project.

Tape	Date	Start * (UTC time)	End (UTC time)	Length	General Location	Original Field Tape
1	July 28	16:48:34	17:09:23	22 min	Barrow Spit and Plover Islands (FW)	ARC01-14
2	July 24	22:02:29	22:59:54	58 min	Barrow to Dease Inlet (H)	ARC01-05
3	July 24	23:03:32	00:09:54	60 min	Admiralty Bay (H)	ARC01-06
4	July 24	00:12:01 *fuel break* 02:20:19	00:28:25 *fuel break* 02:03:47	62 min	Dease Inlet to Smith River (H)	ARC01-07
5	July 26	21:29:57	22:22:50	51 min	Atigaru Point to Smith River (FW)	ARC01-13
6	July 24	19:19:02	19:53:34	34 min	Kogru River (H)	ARC01-04
7	July 25	20:26:39	21:25:28	60 min	Stains River to central Camden Bay (H)	ARC01-08
8	July 25	21:29:02	22:07:22	35 min	Central Camden Bay to Barter Island (H)	ARC01-09
9	July 25	22:36:50	23:35:20	60 min	Barter Island to Egfaksrak River (H)	ARC01-10
10	July 25	23:36:58 00:18:32	00:12:56 00:43:06	60 min	Egaksrak River to Canadian Border (*transit)* Icy Reef Barrier (Demarcation Bay to Nuvagapak) (H)	ARC01-11
11	July 25	00:45:12 *fuel Break* 01:39:01 02:27:54	01:09:55 *fuel Break* 02:26:20 02:28:18	57 min	Barrier Islands – Angus Lagoon to Flaxman Island (H) (multiple short breaks between islands) *(Land)* Ground Check Flaxman Island	ARC01-12

* The times are Universal Time Coordinated (UTC) times based on world GPS references to Longitude zero. Local Alaska daylight times are contained in the data files and are UTC –8 hours.

The DVD disks provided for this project were recorded using the DVD+R/W format. These disks are compatible with most recent DVD-ROM and DVD video Players. Some older first-generation disk drives and players may not be able to read these disks as they misinterpret the surface reflectivity layer. A complete and updated list of both DVD-ROM drives and DVD Players that are compatible with the DVD+R/W format can be found at the following web site: http://www.dvdplusrw.org/index.html.

Each videotape was digitized and transcoded into MPEG 2 for mastering to movie DVDs. These disks can be played back on most standard desktop DVD players connected to a television or video monitor. They can also be played on computers with DVD-ROM drives and appropriate DVD decoding hardware and/or software programs. The digital video files are interlaced North American Standard NTSC data streams. Playback on computer monitors will result in slightly lower resolutions, as the individual video fields are de-interlaced for frame playback

The video digital files were also provided in both MPEG 1 and MPEG 2 as raw digital files for each tape. The MPEG 1 files are natively compatible with most current computer multimedia players such as Microsoft Windows Media Player. The MPEG 2 format files that were used for video DVD production will provide a higher resolution image but are not natively compatible with Windows Media Player. A third party plug-in will be required to play these files. A Windows Media Player plug-in codec for the MPEG 2 format used to encode these files can be found at the following web site. LSX-MPEG Player (Windows Media Player add-on) http://www.ligos.com.

Because of the high data rates required to play back digital video, a moderate to high end computer system will be required for full resolution and smooth motion playback. Low end Pentium or earlier systems may not be able to properly handle these files unless additional hardware support is added.

Because of funding limitations, only VHS videotapes (not DVDs) were produced for the Chukchi Sea area. Table 3 shows the flight logs for the 9 videotapes.

Table 3. Videotape log for the 9 tapes for the Chukchi Sea mapping project.

Tape	Date	Start (UTC time)	End (UTC time)	Length	General Location	Original Field Tape
1	July 28	00:17:33	00:45:27	26 min	Cape Seppings to Point Hope	ARC01-18
2	July 29	16:27:51	17:25:32	58 min	Point Hope to Kasegaluk Lagoon	ARC01-19
3	July 29	17:29:39	18:28:32	61 min	Kasegaluk Lagoon (inner shoreline)	ARC01-20
4	July 29	20:35:01	21:36:12	62 min	Kasegaluk Lagoon to Barrow	ARC01-22
5	July 28 July 24	16:48:32 22:02:29	16:53:02 22:12:44	5 min 12 min	Barrow to Plover Point Barrow Airport to Tekegakruk Point	ARC01-14 ARC01-05
6	July 28	17:49:48 18:51:08	18:38:55 18:54:52	50 min 5 min	Peard Bay (*transit)* small river in west Kugrua Bay	ARC01-15
7	July 28	19:05:25	19:59:38	54 min	Kuk River Embayment	ARC01-16
8	July 29	19:26:44 20:07:43	19:44:22 20:26:08	17 min 19 min	Kungok River (*transit)* Avak Inlet	ARC01-21
9	July 28	20:55:52	21:55:09	60 min	Barrier Islands from Kilimantaui to the south end of Kasegaluk Lagoon	ARC01-17

Maps were also produced to show the aerial video flight lines for each individual tape (Appendix A for the Beaufort Sea and Appendix B for the Chukchi Sea). They are for presentation only. The map sets were created in ArcView using the GPS flight line logs. Each line is actually made up of individual dots at 2-second intervals. The exact time and position of each dot is included in the attached data files and can be referenced in ArcView or other mapping programs as well as databases or spreadsheets. These times and positions are the same as displayed at the bottom of the video image.

The times displayed on the map sheets are a subset of the logged times and are included as a general reference for persons not able to access the digital log files. The times displayed are Universal Time Coordinated (UTC) times based on world GPS references to Longitude zero. This is the same as the old Greenwich Mean Time (GMT). Local Alaska daylight times are contained in the data files (UTC-8 hours).

The maps used in this report were corrected to NAD83/WGS84 to match the GPS flight-line data. It may appear in several areas that the flight lines do not match the shoreline, especially along the barrier islands. The map base is generally compiled from 1955 aerial photography with a few unverified corrections from late 1970's and early 1980's. The North Slope is a very dynamic environment; eroding tundra and shifting sand barriers are common. The flight lines represent the current shoreline position.

4.0 REFERENCES CITED

Petersen, J., J. Michel, S. Zengel, M. White, C. Lord, and C. Plank, 2002. Environmental Sensitivity Index Guidelines, Version 3.0. Hazardous Materials Response Division, Office of Response and Restoration, National Oceanic and Atmospheric Administration, Seattle, Washington, NOAA Tech. Memo. NOS OR&R 11, 89 pp. + appendices.

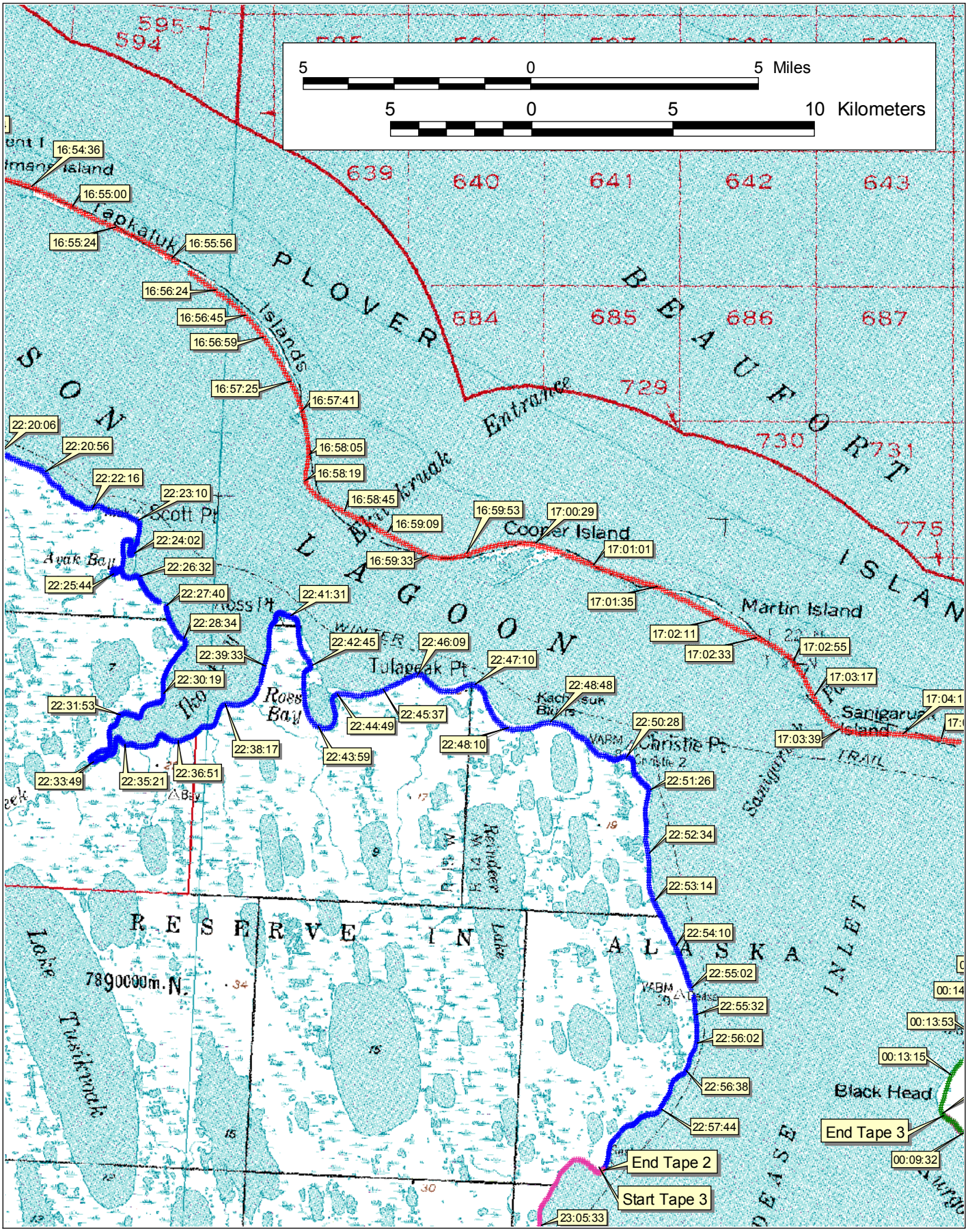
APPENDIX A:

Aerial video flight lines for the Beaufort Sea videotapes

North Slope Videotape Survey 2001

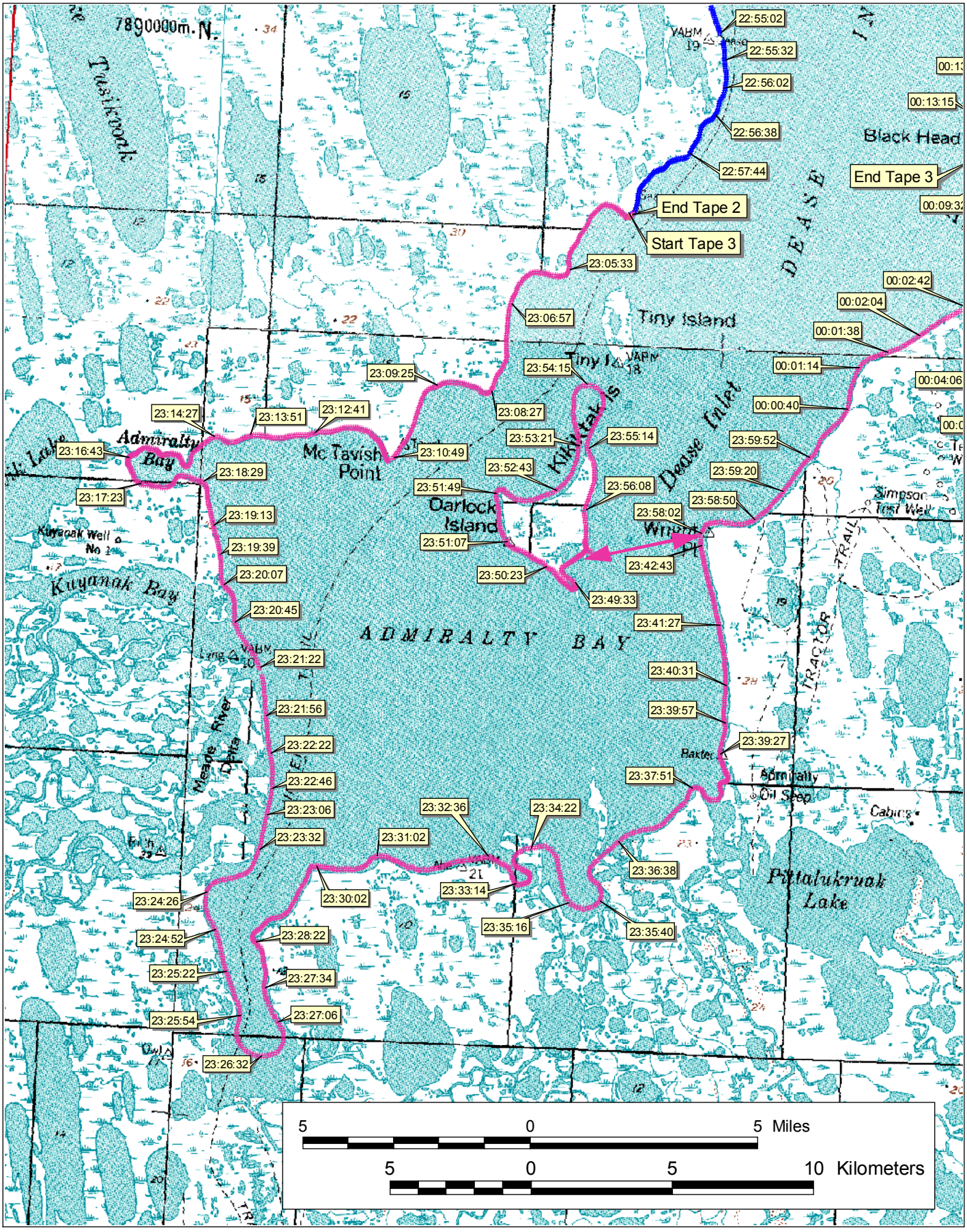
MAP 1

North Slope Videotape Survey 2001



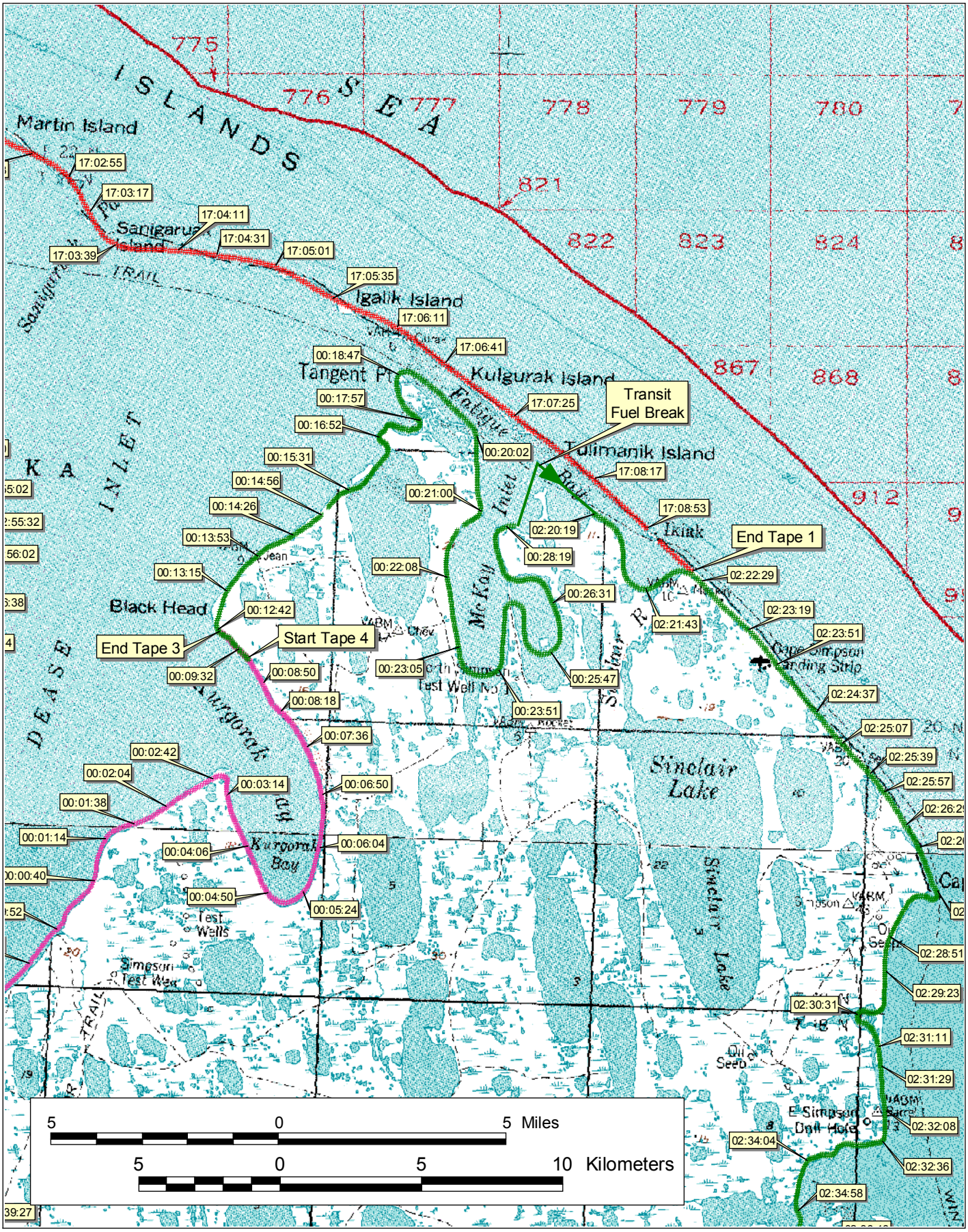
MAP 2

North Slope Videotape Survey 2001



MAP 3

North Slope Videotape Survey 2001



MAP 4

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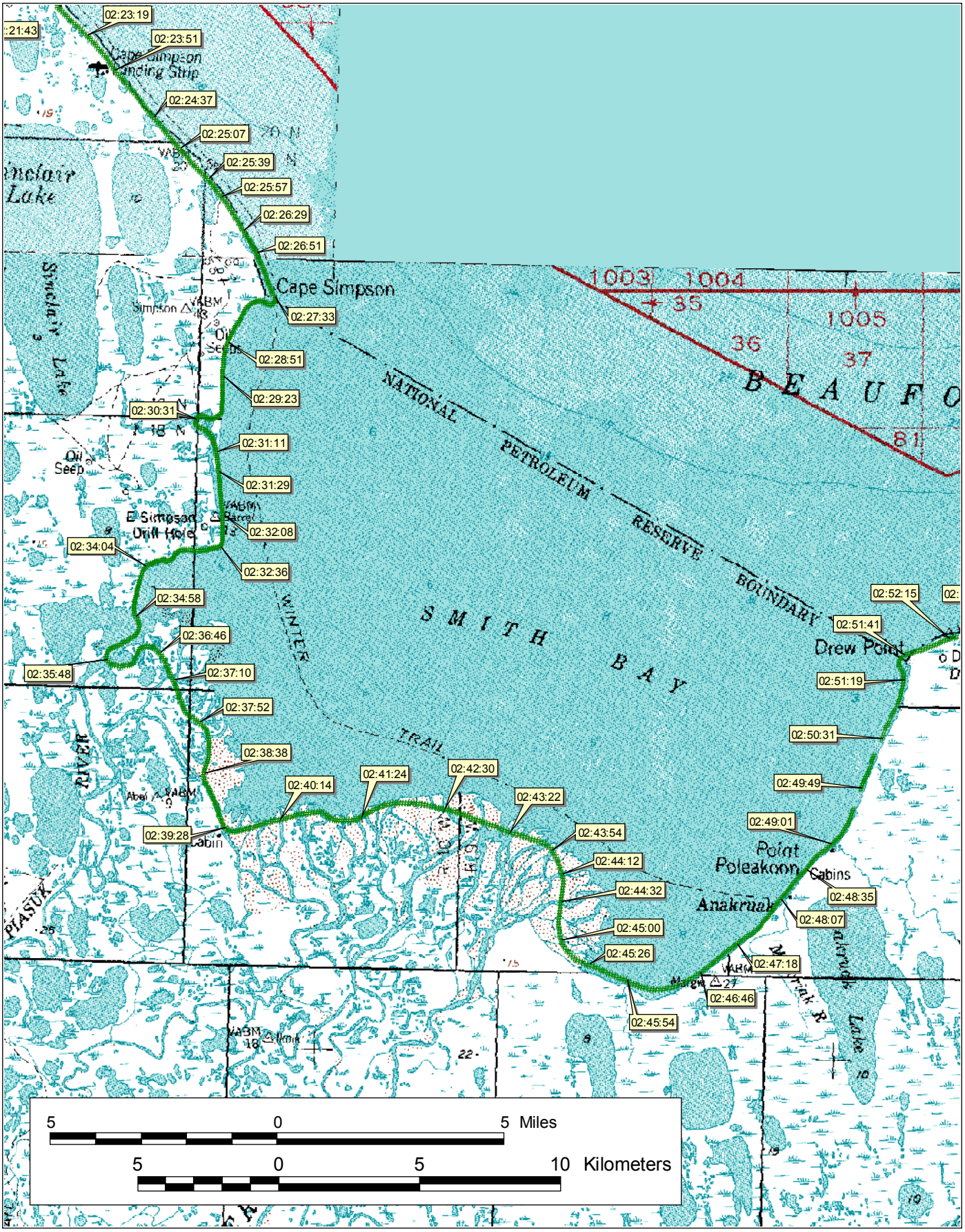

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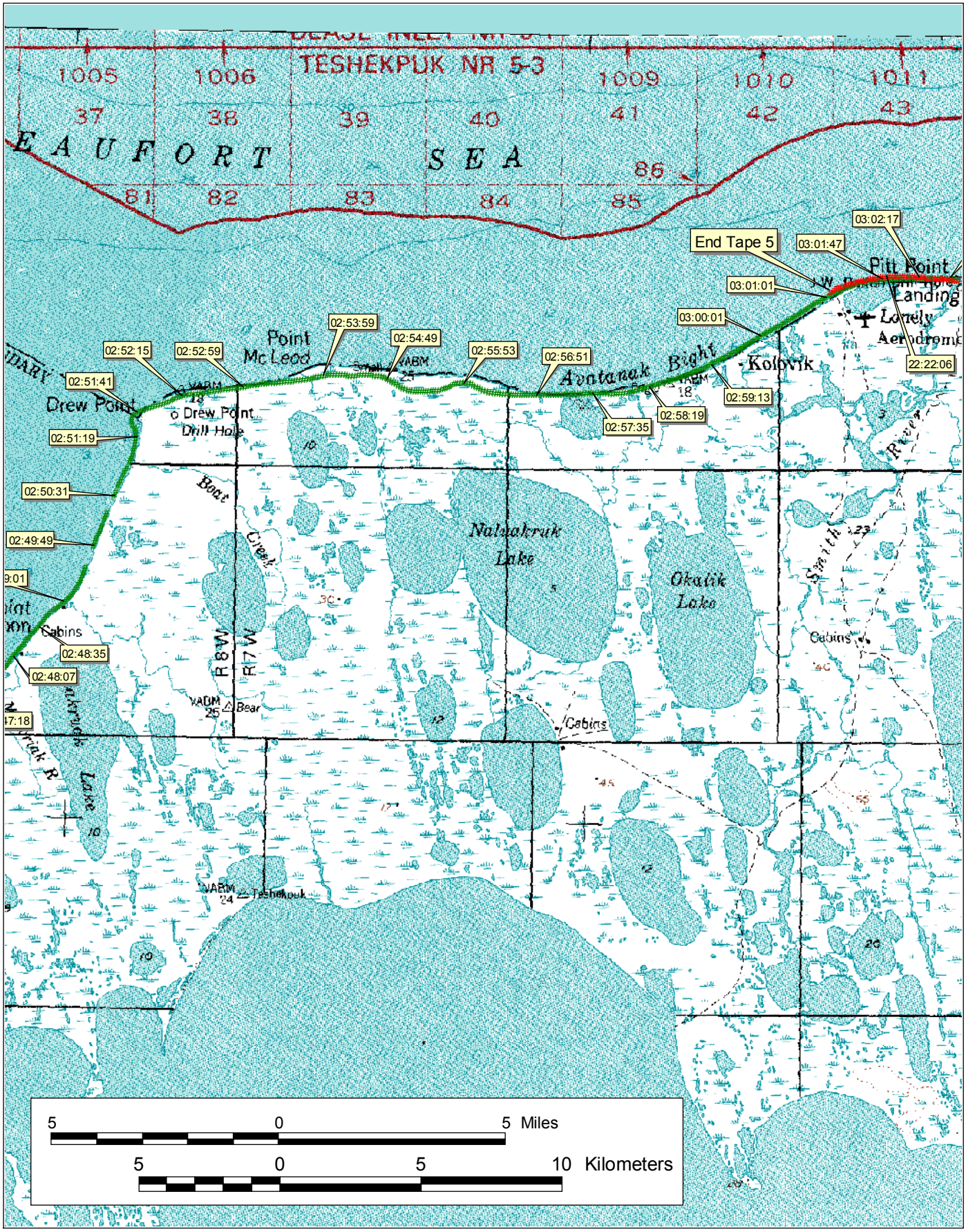


MAP 6

North Slope Videotape Survey 2001

MAP 7

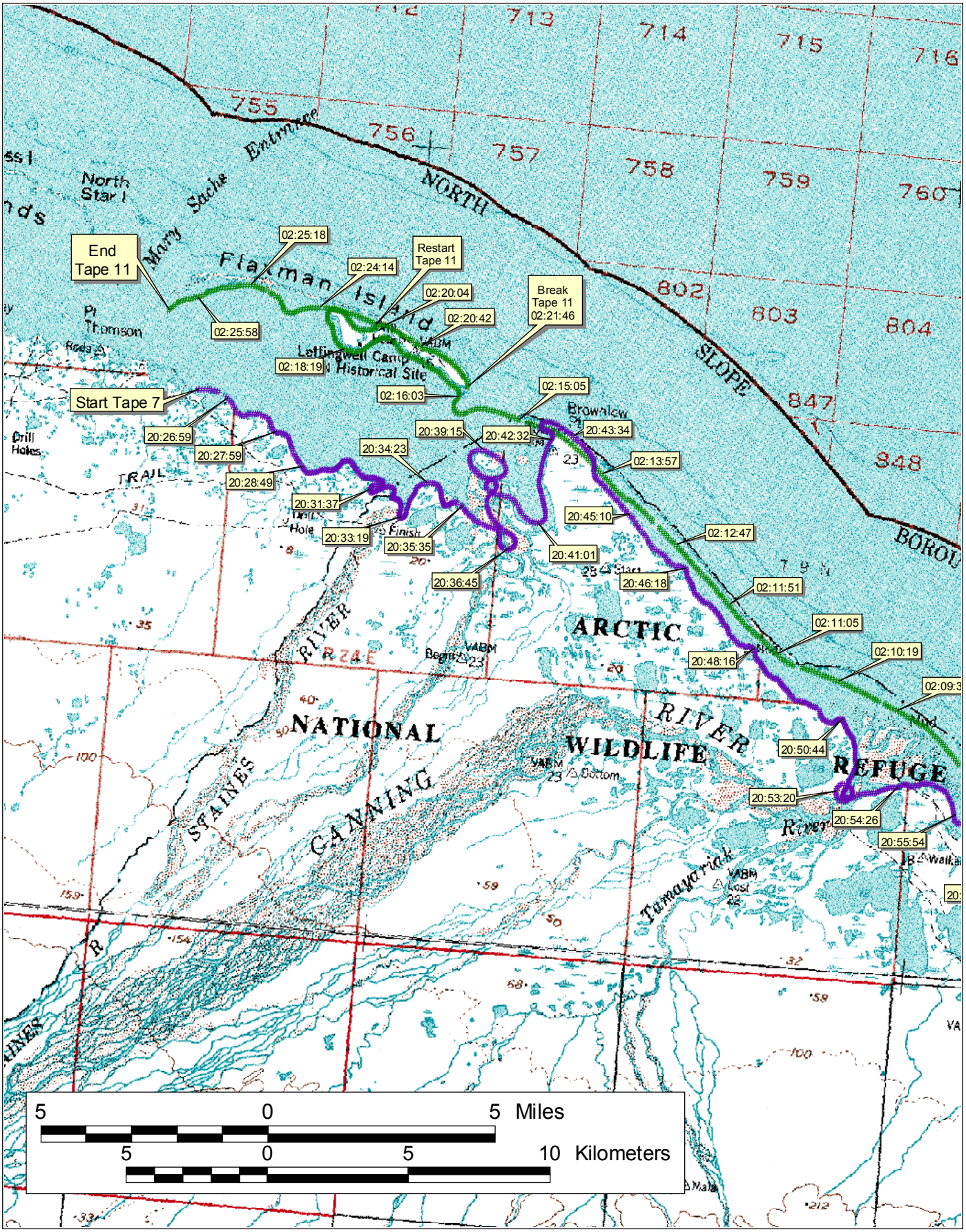
North Slope Videotape Survey 2001

MAP 8

North Slope Videotape Survey 2001

MAP 9

North Slope Videotape Survey 2001



MAP 10

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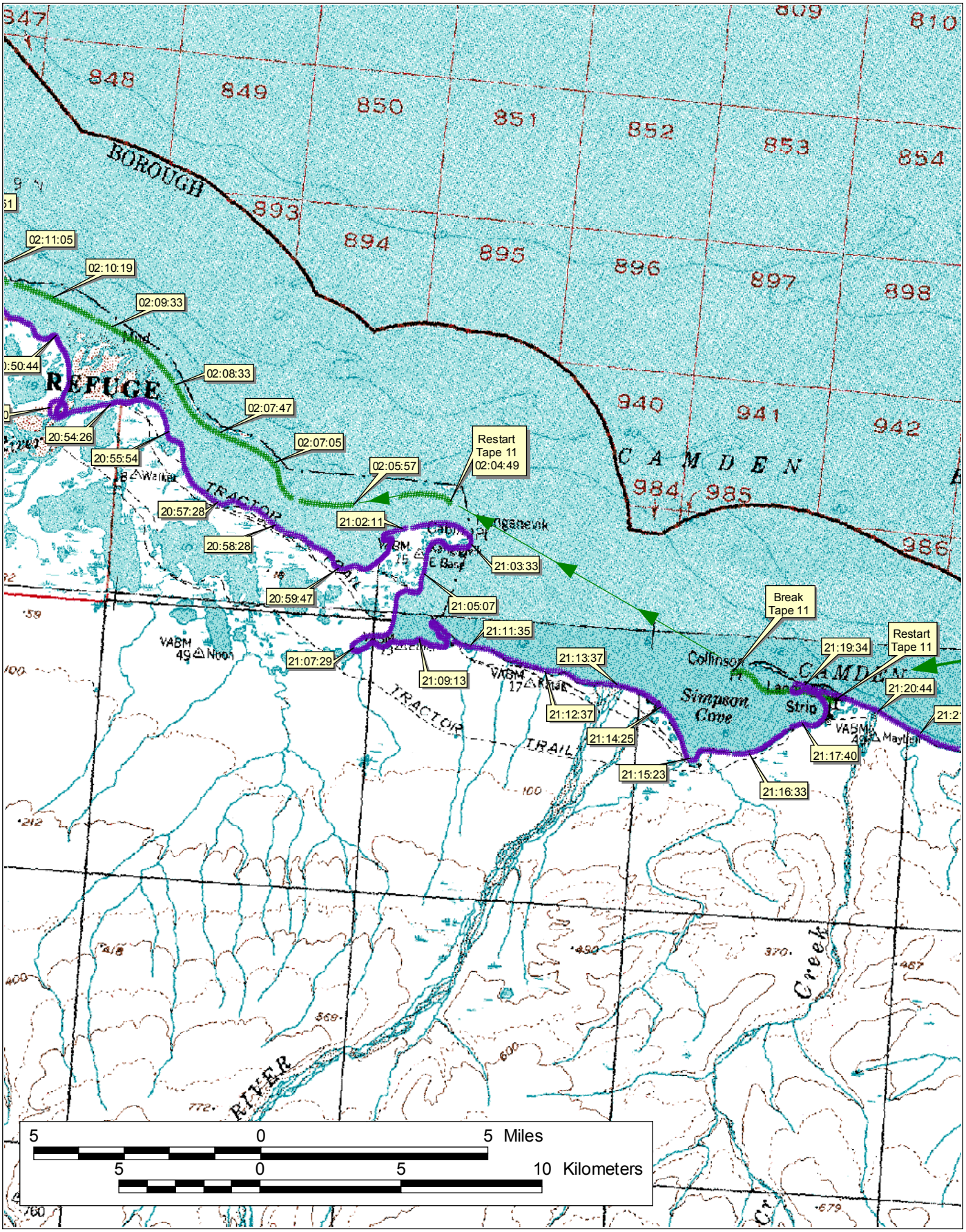

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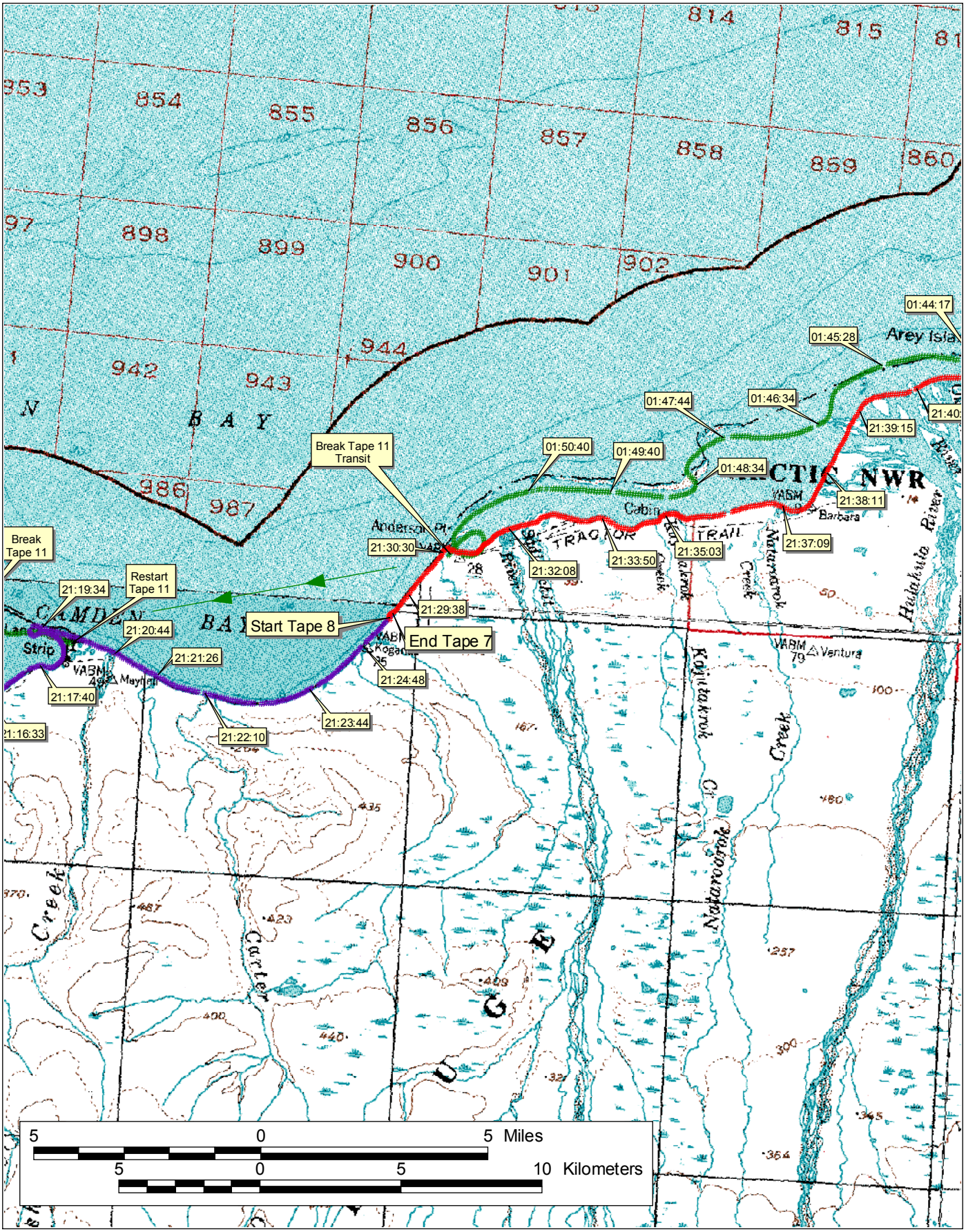

MAP 12

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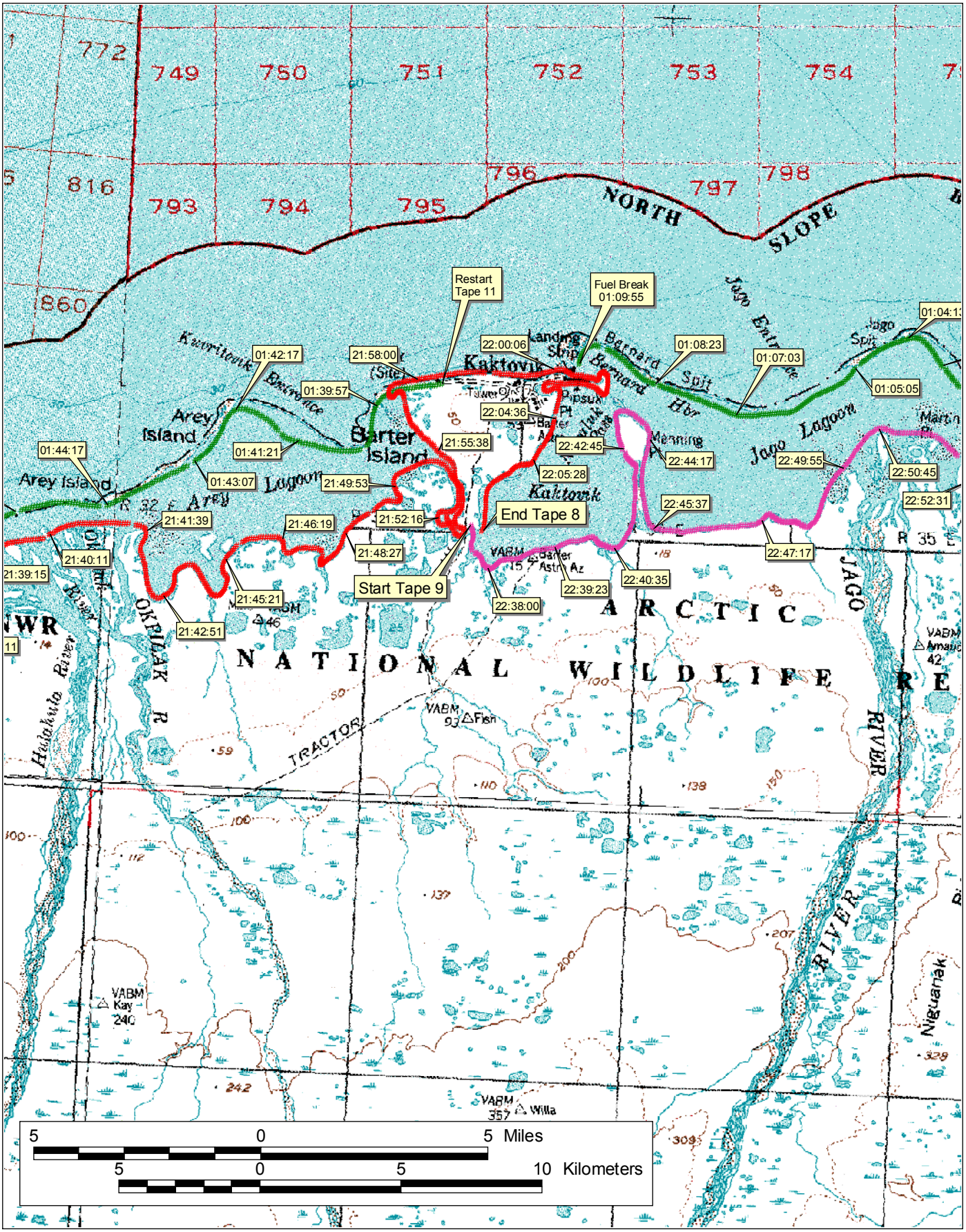

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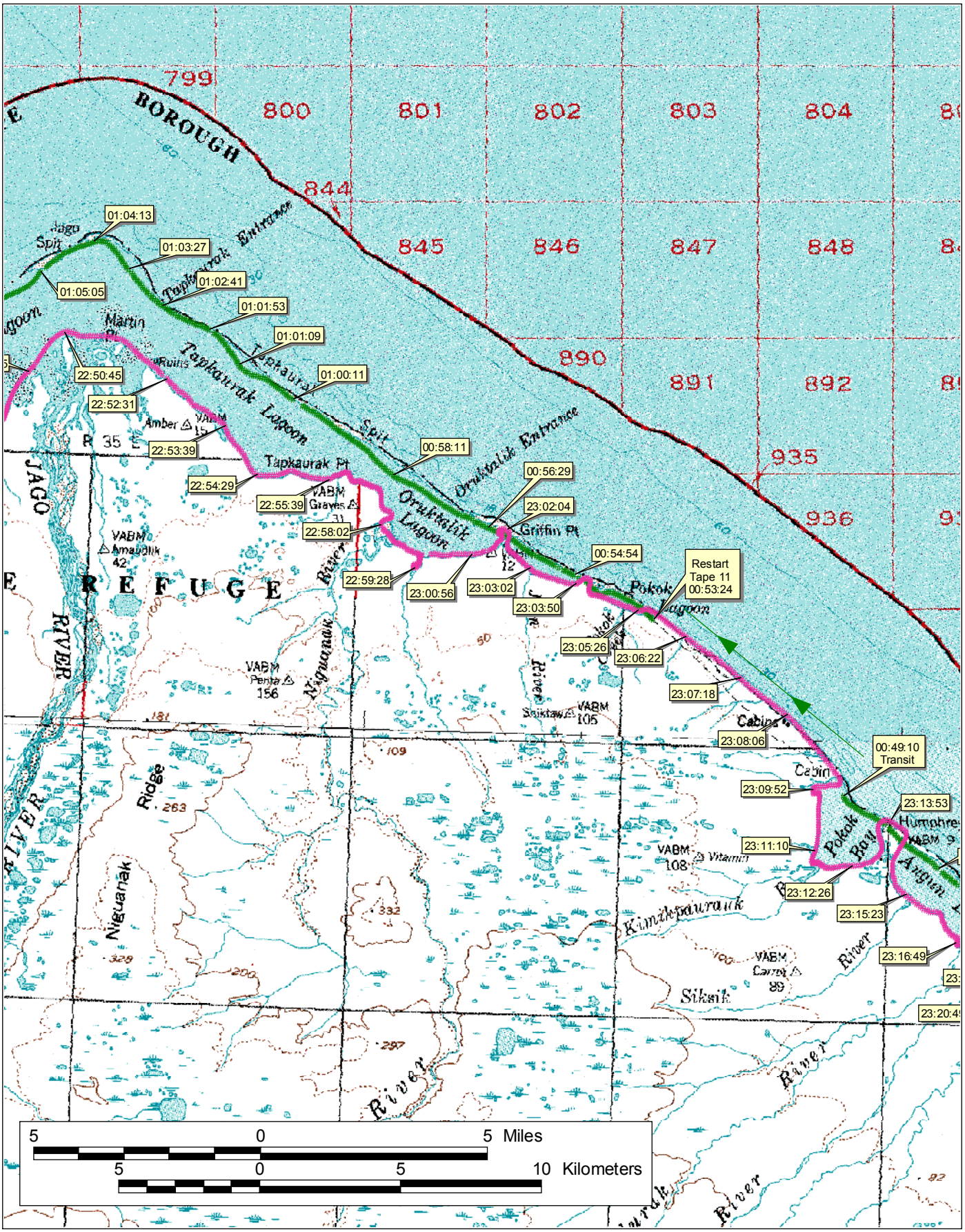

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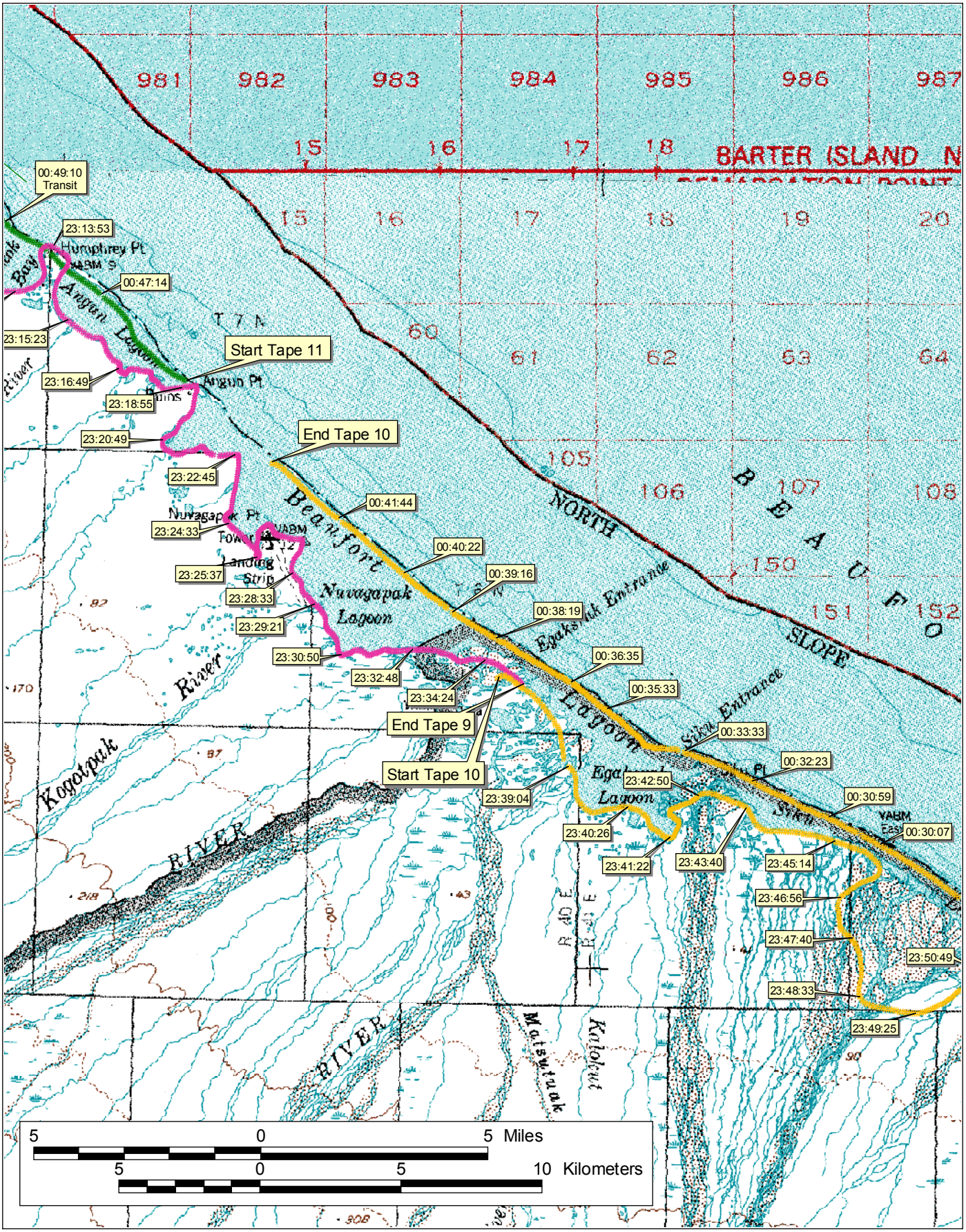


MAP 15

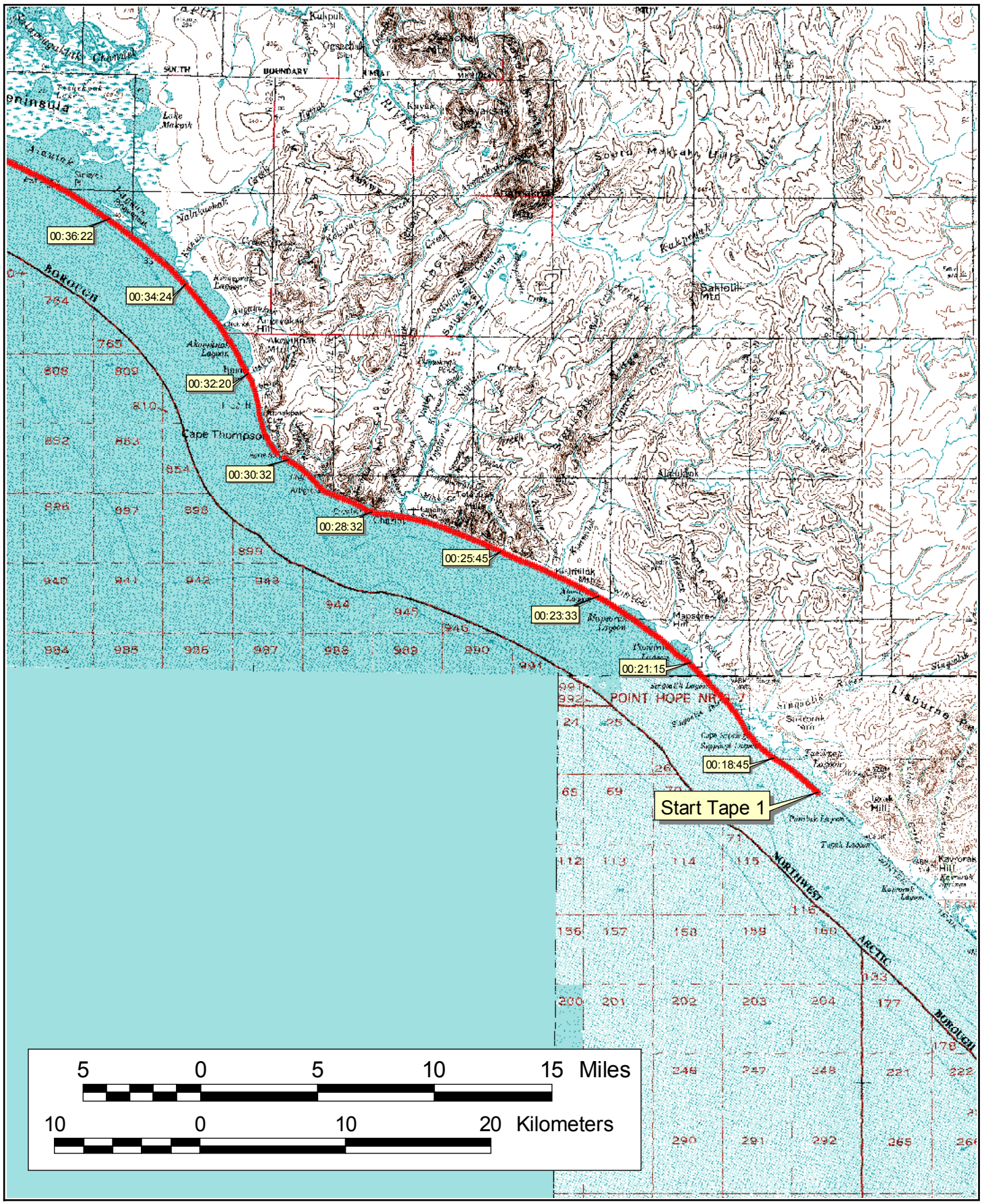
North Slope Videotape Survey 2001

MAP 16

APPENDIX B:

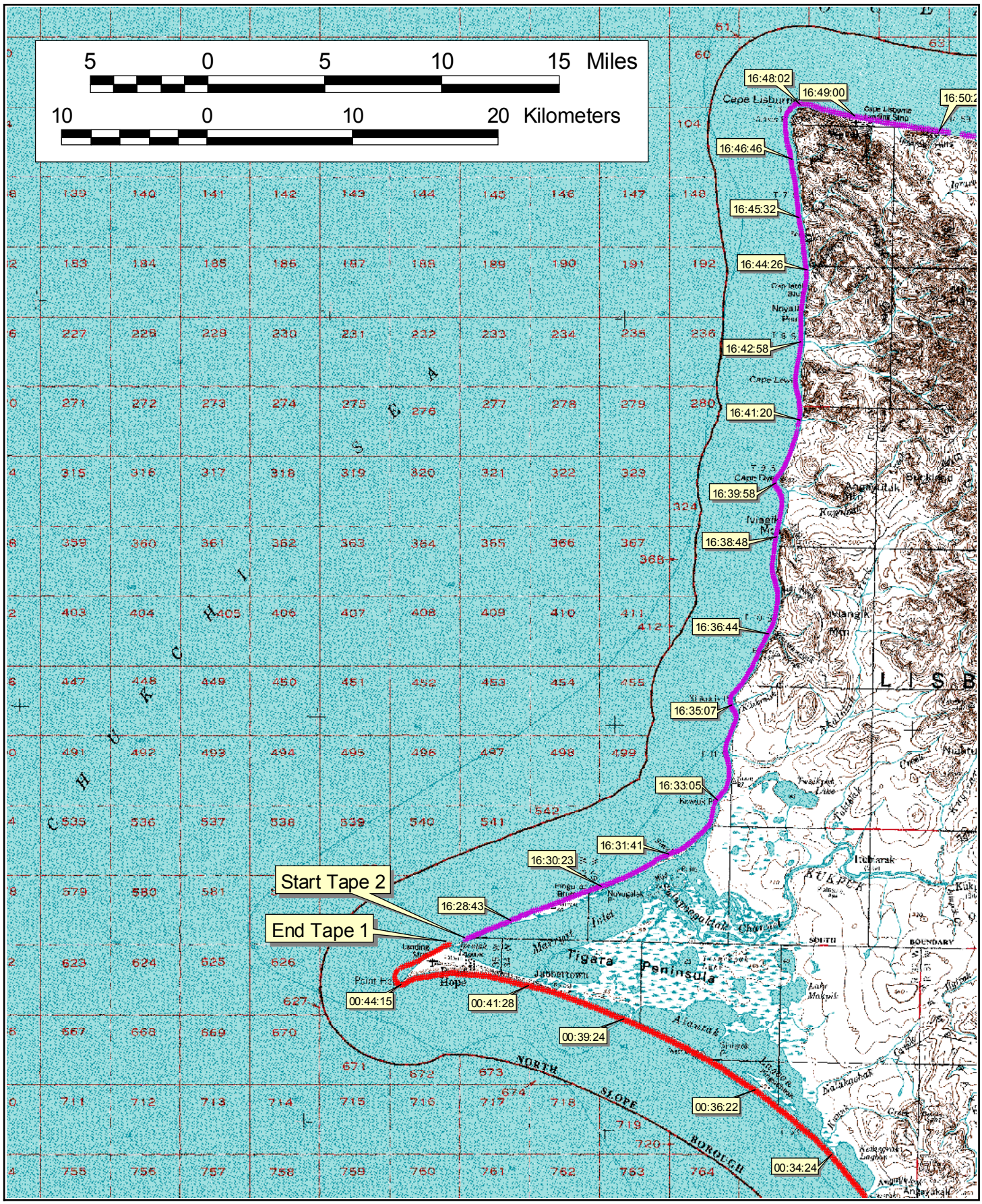
Aerial video flight lines for the Chukchi Sea videotapes

Chukchi Sea Videotape Survey 2001



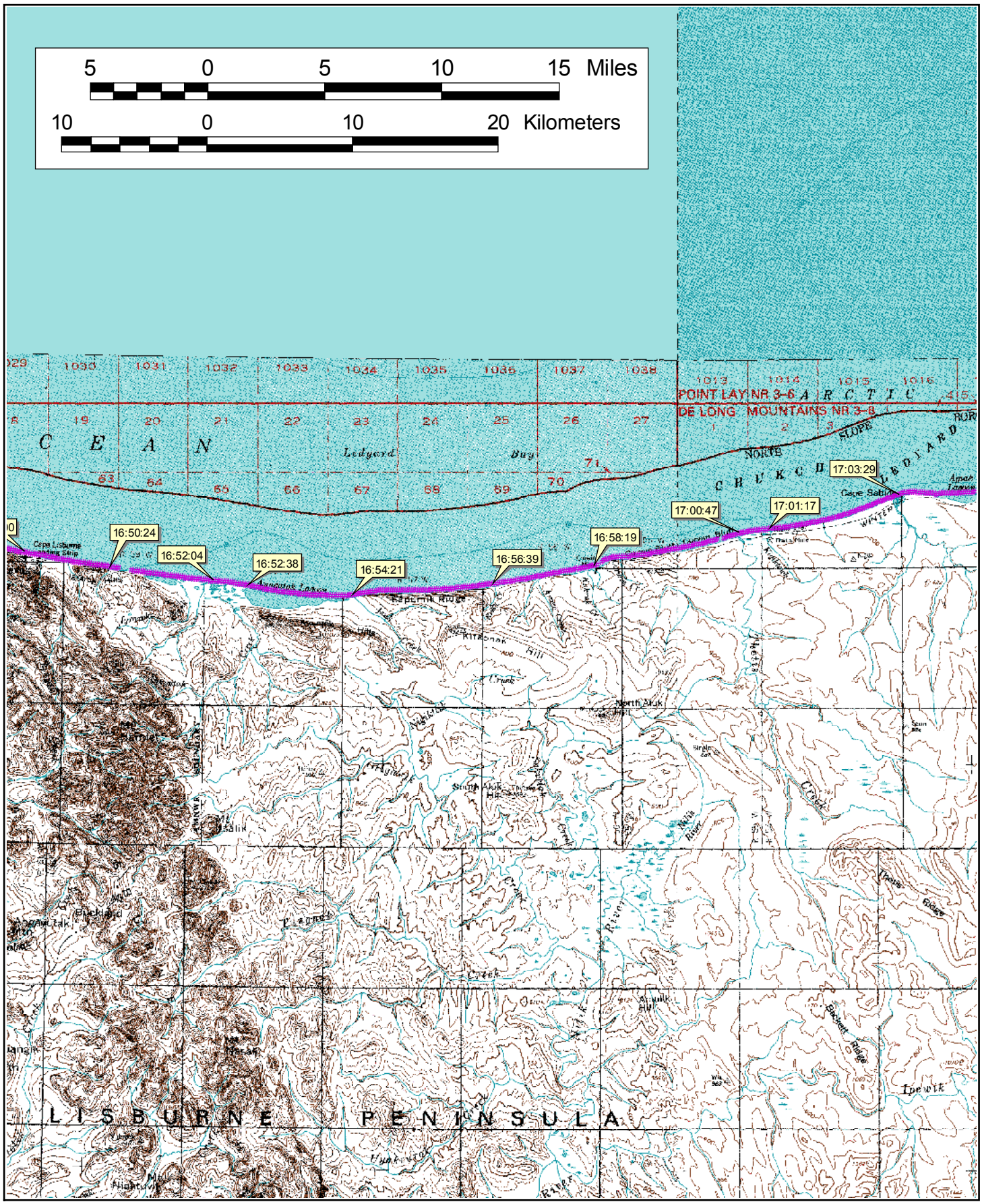
MAP 1

Chukchi Sea Videotape Survey 2001



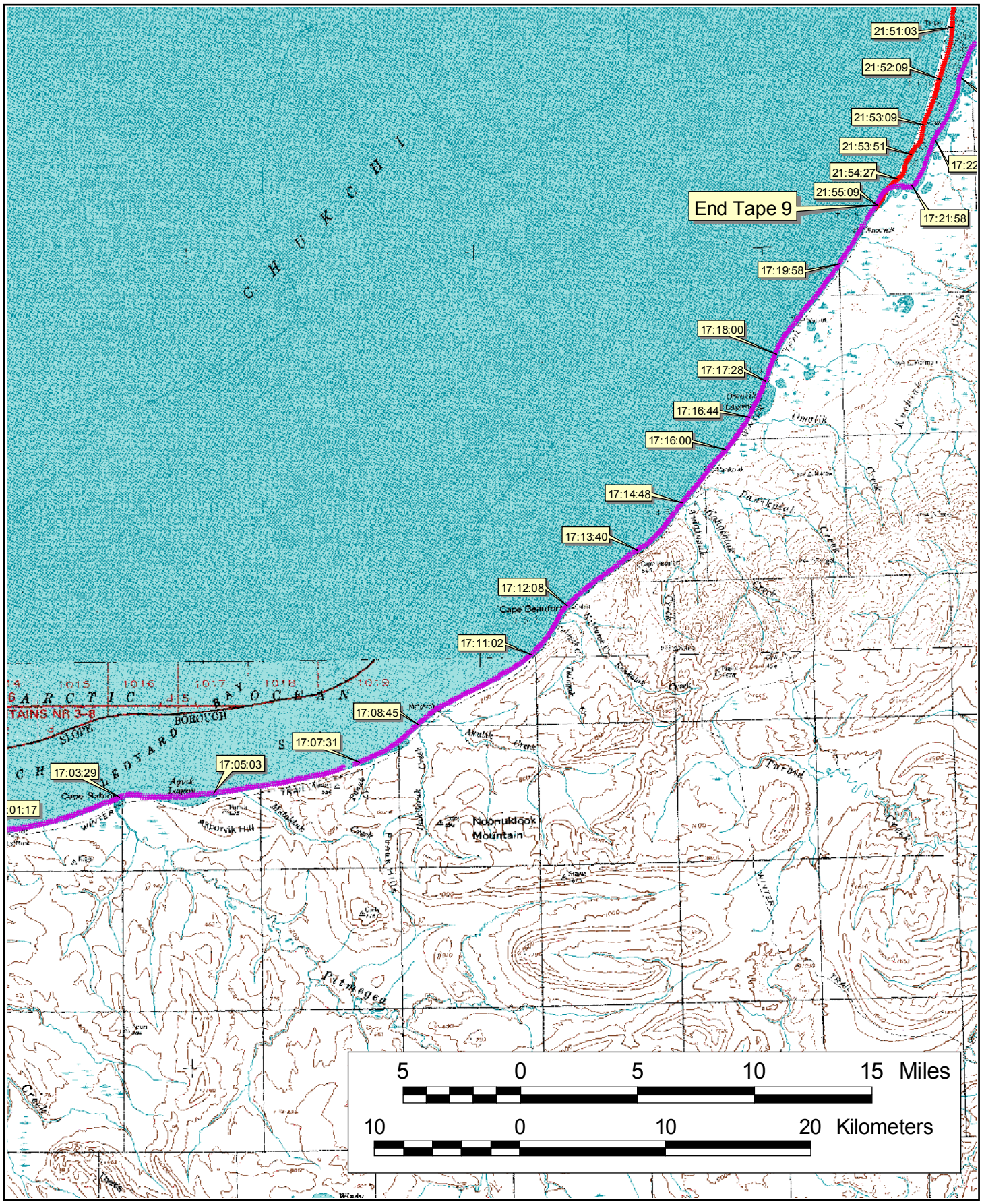
MAP 2

Chukchi Sea Videotape Survey 2001



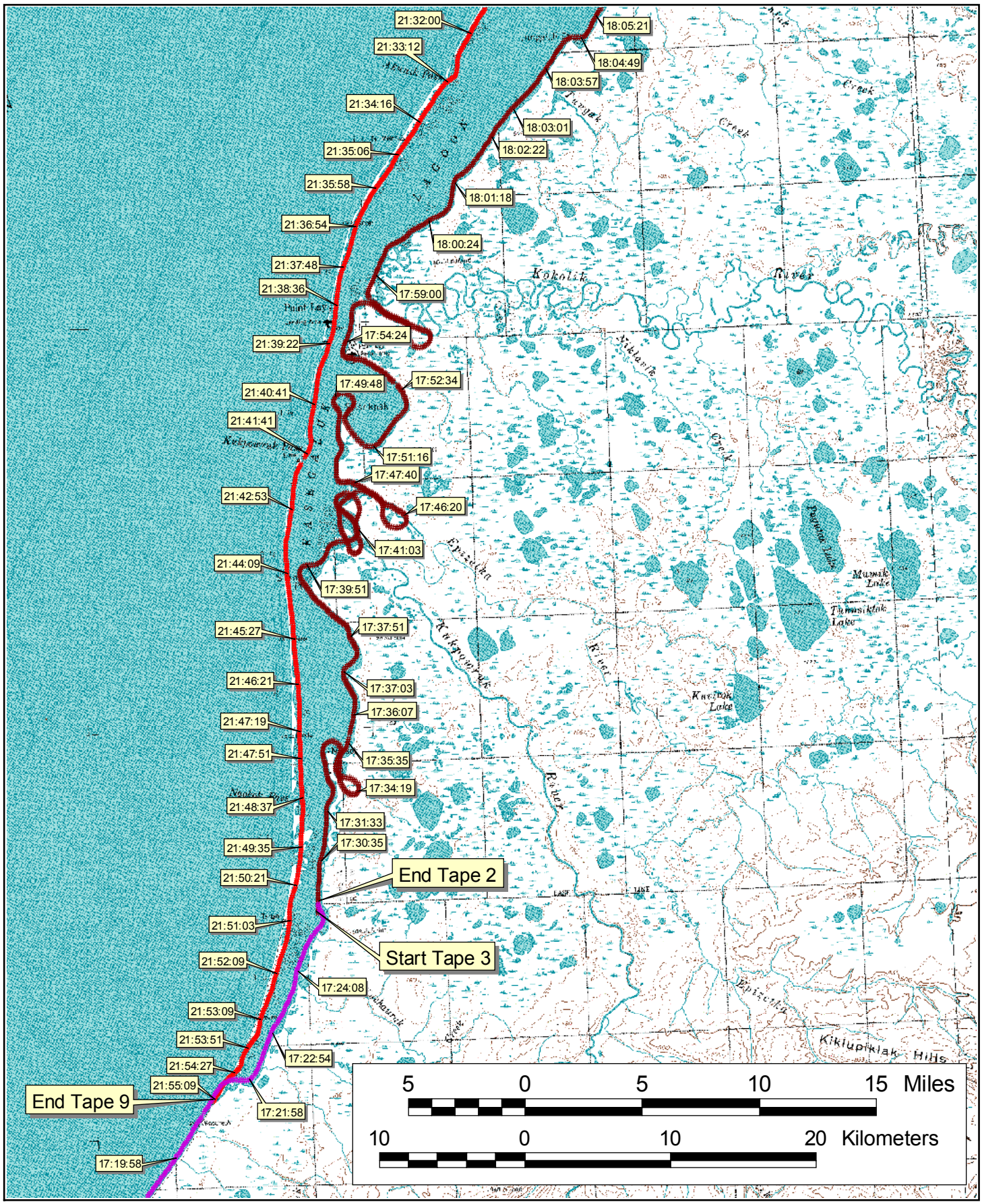
MAP 3

Chukchi Sea Videotape Survey 2001



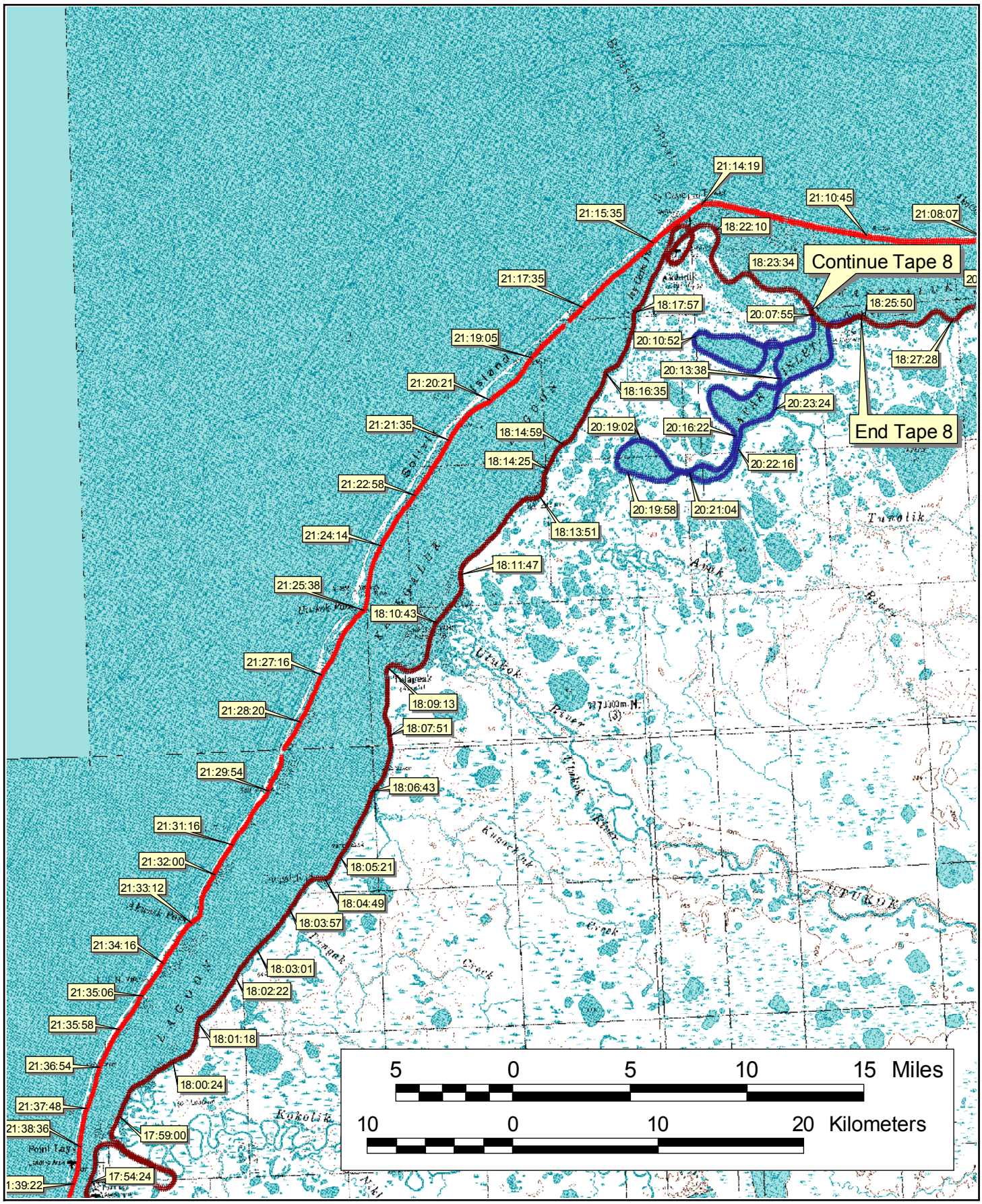
MAP 4

Chukchi Sea Videotape Survey 2001



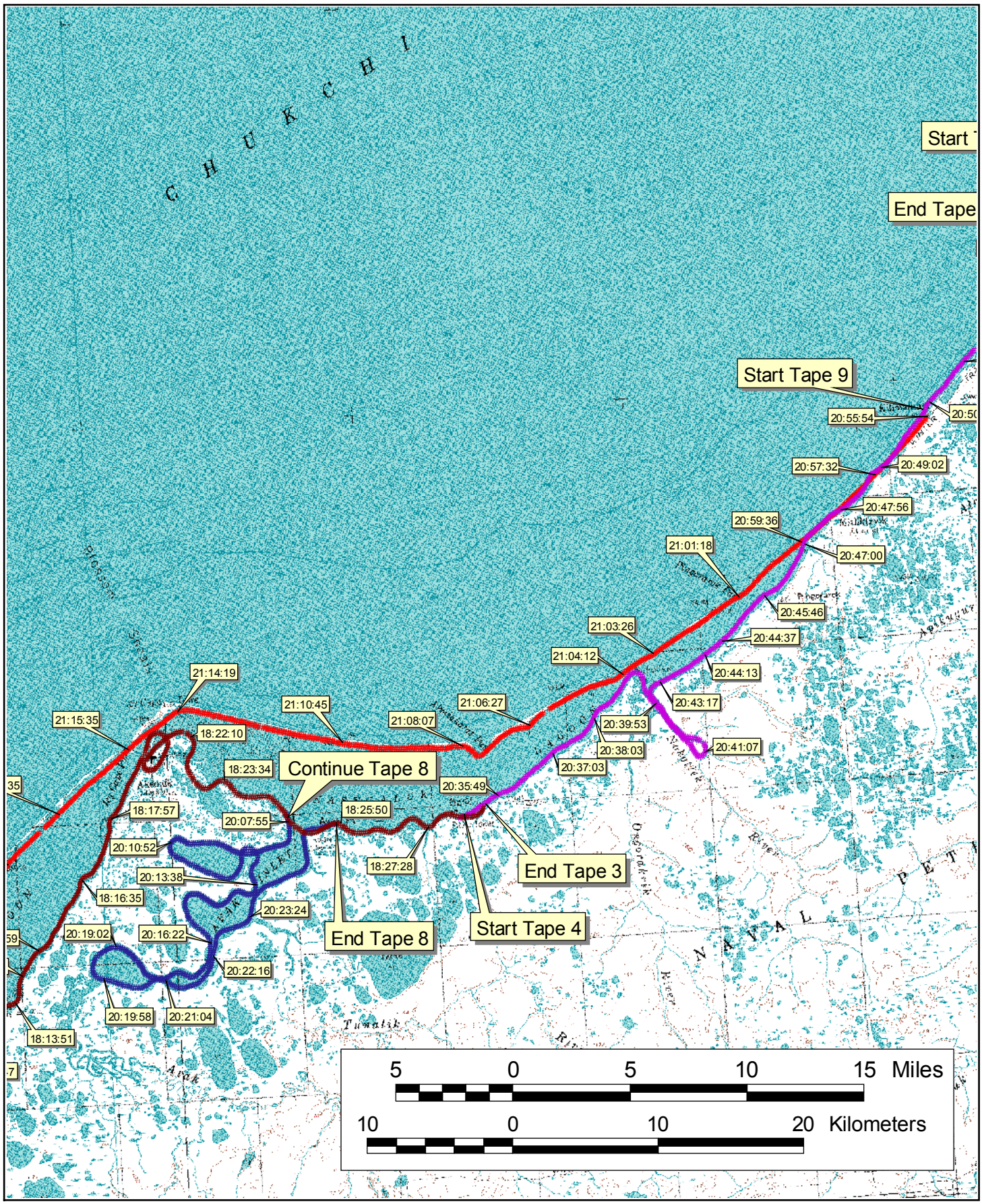
MAP 5

Chukchi Sea Videotape Survey 2001



MAP 6

Chukchi Sea Videotape Survey 2001



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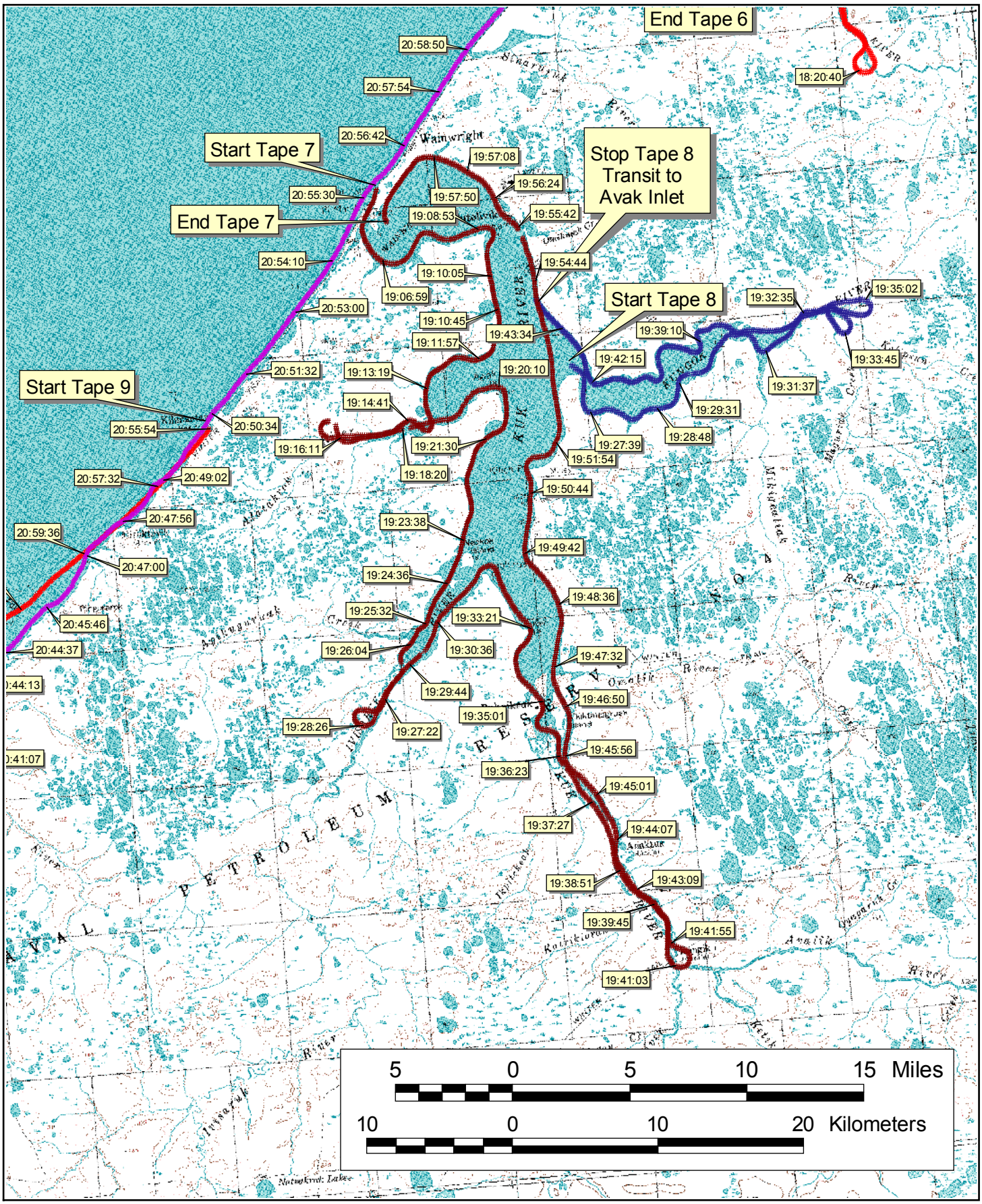
Chukchi Sea Videotape Survey 2001

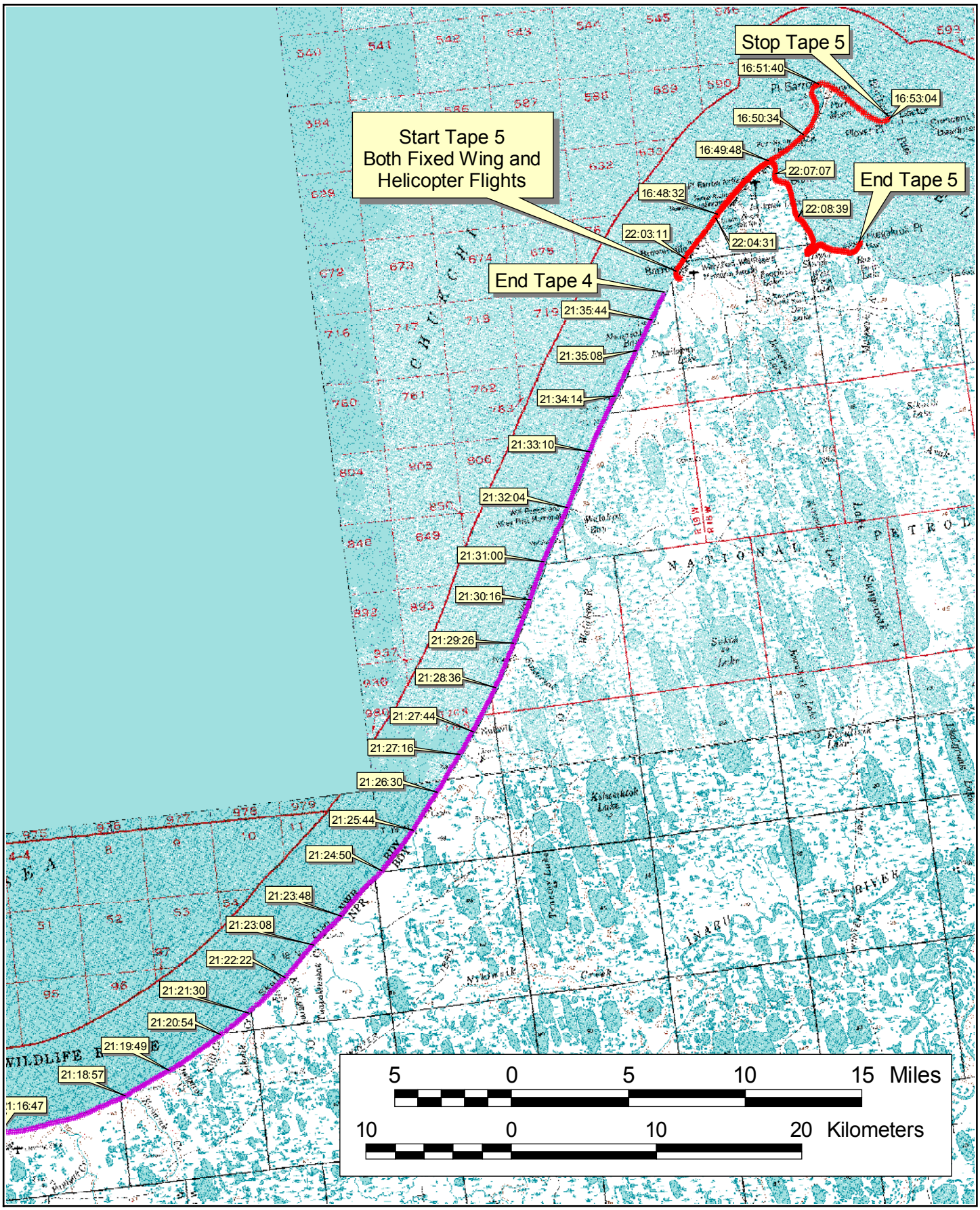


MAP 8

Chukchi Sea Videotape Survey 2001

MAP 9

Chukchi Sea Videotape Survey 2001



MAP 10