FOREWORD

The British Columbia Forest Act (1978) states that the Chief Forester shall develop and maintain an inventory of the land and forests in the Province, and shall assess the land in the Province for its potential for growing trees continuously, providing forest oriented recreation, producing forage for livestock and wildlife, and for accommodating other forest uses. Also, the Ministry of Forests Act (1978) requires a periodic resource analysis report containing a description of the inventory of the forest and range resources in the Province, a description of the location and extent of areas of forest land in the Province that have been denuded of timber through harvesting or otherwise and have not become re-stocked with a commercially valuable species of timber, or are producing timber at the rate that is substantially lower than their potential. In addition, the Minister of Forests is required to submit to the Lieutenant-Governor in Council an annual report which must include a summary of forest land in the Province, showing areas denuded of forest during the year, areas re-stocked during the year and areas the productivity of which has been improved during the year.

In order to implement the requirements of the new forest legislation, the Inventory Branch of the Ministry of Forests has acquired new technology and has developed new approaches for conducting forest and range inventory. The Forest and Range Inventory Manual, consisting of eleven chapters, the Five-Year Plan for Forest and Range Inventory in British Columbia: 1981-1985, and the inventory handbooks, namely the Field Pocket Handbook, the Helicopter Camera Boom Instruction and Operation Handbook, the Colour Stereogram Handbook, and the Stereocord Handbook, describe the procedures for planning, conducting and auditing provincial forest and range inventories.

F. Hegyi, R.P.F.
DIRECTOR
MINISTRY OF FORESTS
INVENTORY BRANCH

FOREST AND RANGE INVENTORY MANUAL

INVENTORY BRANCH STAFF:
MANAGERS AND PROJECT LEADERS

Director
Hegyi, F. (Frank)

Manager, Inventory Statistics
Calder, C.J. (Cliff)
Forestry and Range Statistics Officer
Spandli, I. (Imre)
Computerized Mapping Coordinator
Blyth, M.S. (Malcolm)

Manager, Inventory Methodology
Quenet, R.V. (Robin)
Forest Classification and Sampling Officer
McLellan, J.F. (Jack)
Range Classification and Sampling Officer
McMinn, A.R. (Albert)
Remote Sensing Officer
Nemeth, J. (Joe)
Photo Mensuration Officer
Bradatsch, H. (Helmut)

Manager, Depletion and Update
Fligg, D. (Doug)
Depletion Officer
Hall, B.M. (Brian)
Decay and Waste Officer
Kiss, J. (John)

Manager, Growth and Yield
Allison, G.W. (George)
Forest Growth Monitoring Officer
Magdanz, H.A.O. (Hans)
Growth Modelling Officer
Finding, S.L. (Scott)
Site Evaluation Officer
Szy, F. (Frank)
Forest Growth Projection Officer
Viszlai, J. (John)
MINISTRY OF FORESTS
INVENTORY BRANCH

FOREST AND RANGE INVENTORY MANUAL
VOLUME I

CONTENTS

Chapter 1 - Emergency Procedures
Chapter 2 - Environmental Protection Areas
Chapter 3 - Forest Classification
Chapter 4 - Forest Sampling
Chapter 5 - Range Classification and Sampling
Chapter 6 - Photogrammetry
Please make the following changes to your copy of the above Ministry manual. Update the Revision Register (FS 1120) in your manual and file this notice immediately after the Register page. Current revisions on the attached pages are indicated by vertical lines alongside the revised text.

<table>
<thead>
<tr>
<th>ACTION (Remove/Insert)</th>
<th>(VOL) CHAPTER - SECTION - SUBJECT</th>
<th>PAGE(S)</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>REMOVE</td>
<td>I-3-FOREST CLASSIFICATION</td>
<td>ALL</td>
<td>MARCH 1988</td>
</tr>
<tr>
<td>INSERT</td>
<td>I-3-FOREST CLASSIFICATION</td>
<td>ALL</td>
<td>1991</td>
</tr>
<tr>
<td>INSERT</td>
<td>I-5-PREPARATION OF FOREST COVER SOURCE MAPS FOR THE FOREST RESOURCE INFORMATION SYSTEM</td>
<td>ALL</td>
<td>1990</td>
</tr>
<tr>
<td>INSERT</td>
<td>II-11-FOREST RESOURCE GEODEMIC INFORMATION SYSTEM</td>
<td>ALL</td>
<td>1991</td>
</tr>
<tr>
<td>INSERT</td>
<td>II-12-MAP OVERLAYS</td>
<td>ALL</td>
<td>1991</td>
</tr>
</tbody>
</table>

THE ENCLOSED 4 CHAPTERS ARE IN DRAFT FORM AND WILL BE REPLACED BY FINAL FORM IN APPROXIMATELY ONE YEAR. PLEASE USE THE ATTACHED AS REFERENCE FOR THE INTERIM AND DISCARD ANY INFORMATION PRESENTLY OCCUPYING THESE CHAPTERS OF YOUR MANUAL.
FOREWORD

The British Columbia Forest Act (1978) states that the Chief Forester shall develop and maintain an inventory of the land and forests in the Province, and shall assess the land in the Province for its potential for growing trees continuously, providing forest oriented recreation, producing forage for livestock and wildlife, and for accommodating other forest uses. Also, the Ministry of Forests Act (1978) requires a periodic resource analysis report containing a description of the inventory of the forest and range resources in the Province, a description of the location and extent of areas of forest land in the Province that have been denuded of timber through harvesting or otherwise and have not become re-stocked with a commercially valuable species of timber, or are producing timber at the rate that is substantially lower than their potential. In addition, the Minister of Forests is required to submit to the Lieutenant-Governor in Council an annual report which must include a summary of forest land in the Province, showing areas denuded of forest during the year, areas re-stocked during the year and areas the productivity of which has been improved during the year.

In order to implement the requirements of the new forest legislation, the Inventory Branch of the Ministry of Forests has acquired new technology and has developed new approaches for conducting forest and range inventory. The Forest and Range Inventory Manual, consisting of eleven chapters, the Five-Year Plan for Forest and Range Inventory in British Columbia: 1981-1985, and the inventory handbooks, namely the Field Pocket Handbook, the Helicopter Camera Boom Instruction and Operation Handbook, the Colour Stereogram Handbook, and the Sterecord Handbook, describe the procedures for planning, conducting and auditing provincial forest and range inventories.

F. HEGYI, R.P.F.
DIRECTOR
Chapter one, "Emergency Procedures", of the Forest and Range Inventory Manual contains basic first aid and information useful to personnel in field emergencies. This chapter was revised and prepared by E.J. Beadle and A.A. Britneff, R.P.F.
CHAPTER ONE
EMERGENCY PROCEDURES

TABLE OF CONTENTS

1.1 CONTACTS IN CASE OF EMERGENCY
1.11 INVENTORY BRANCH
1.12 FOREST REGIONS
1.13 USEFUL PHONE NUMBERS

1.2 AIRCRAFT AND MARINE EMERGENCY
1.21 FLARE KIT INSTRUCTIONS

1.3 WHEN LOST IN THE BUSH

1.4 EMERGENCY SIGNALS
1.41 RADIO CODE FOR AIR ASSISTANCE
1.42 GROUND TO AIR SIGNALS
   AIR TO GROUND SIGNALS

1.5 BASIC FIRST AID
1.51 ARTIFICIAL (MOUTH-TO-MOUTH) RESUSCITATION
1.52 BLEEDING
1.53 BLISTERS
1.54 BURNS
1.55 DIARRHEA
1.56 FOOD POISONING
1.57 FRACTURES (BROKEN BONES)
1.58 HEAT EXHAUSTION
1.59 HYPOTHERMIA
1.510 SHOCK
1.511 SPRAINS
1.512 UNCONSCIOUSNESS

1.6 LEAVING AN INJURED PERSON IN THE BUSH
CHAPTER ONE

EMERGENCY PROCEDURES

1.1 CONTACTS IN CASE OF EMERGENCY

In the event of an injury, serious illness, or other emergency, KEEP CALM, and:

A. Administer first aid:
   1. check breathing.
   2. stop bleeding.
   3. treat shock.
   4. immobilize fractures.

B. Get medical assistance

C. Notify:
   1. the immediate supervisor,
   2. the Inventory Branch (in the case of inventory branch personnel), and
   3. the pertinent Forest Region.

1.11 INVENTORY BRANCH

<table>
<thead>
<tr>
<th>NAME</th>
<th>TITLE</th>
<th>OFFICE</th>
<th>HOME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frank Hegyi</td>
<td>Director</td>
<td>387-6722</td>
<td>477-0709</td>
</tr>
<tr>
<td>George Allison</td>
<td>Manager, Growth &amp; Yield</td>
<td>387-3051</td>
<td>658-5472</td>
</tr>
<tr>
<td>Cliff Calder</td>
<td>Manager, Inventory Statistics</td>
<td>387-1345</td>
<td>658-5592</td>
</tr>
<tr>
<td>Doug Fligg</td>
<td>Manager, Depletion &amp; Update</td>
<td>387-1345</td>
<td>658-5094</td>
</tr>
<tr>
<td>Robin Quenet</td>
<td>Manager, Inventory Methodology</td>
<td>387-3541</td>
<td>478-6398</td>
</tr>
<tr>
<td>REGION</td>
<td>NAME</td>
<td>TITLE</td>
<td>OFFICE PHONE</td>
</tr>
<tr>
<td>------------</td>
<td>----------------</td>
<td>----------------</td>
<td>------------------</td>
</tr>
<tr>
<td>Vancouver</td>
<td>D.T. Grant</td>
<td>Regional Manager</td>
<td>668-2470 668-2500</td>
</tr>
<tr>
<td></td>
<td>Mel Scott</td>
<td>Inventory Officer</td>
<td>668-2562</td>
</tr>
<tr>
<td>Prince Rupert</td>
<td>J.A. Biickert</td>
<td>Regional Manager</td>
<td>624-2121 (225) 624-5334 (night)</td>
</tr>
<tr>
<td></td>
<td>Boyd Brown</td>
<td>Inventory Officer</td>
<td>624-2121 (302)</td>
</tr>
<tr>
<td>Prince George</td>
<td>J. Cuthbert</td>
<td>Regional Manager</td>
<td>564-0778 (210) 564-9548 (night)</td>
</tr>
<tr>
<td></td>
<td>Gary Darychuk</td>
<td>Inventory Officer</td>
<td>564-0778 (341)</td>
</tr>
<tr>
<td>Cariboo</td>
<td>J.A.D. McDonald</td>
<td>Regional Manager</td>
<td>392-6261 (202) 392-3244 (night)</td>
</tr>
<tr>
<td></td>
<td>Jim Hilton</td>
<td>Inventory Officer</td>
<td>392-6261 (376)</td>
</tr>
<tr>
<td>Kamloops</td>
<td>A.B. Robinson</td>
<td>Regional Manager</td>
<td>374-7741 (311) 374-7744 (night)</td>
</tr>
<tr>
<td></td>
<td>Ron Newman</td>
<td>Inventory Officer</td>
<td>374-7741 (383)</td>
</tr>
<tr>
<td>Nelson</td>
<td>M.C. Isenor</td>
<td>Regional Manager</td>
<td>354-4181 (225) 354-4184 (night)</td>
</tr>
<tr>
<td></td>
<td>Rick Baker</td>
<td>Inventory Officer</td>
<td>354-4181 (280)</td>
</tr>
</tbody>
</table>
1.13 USEFUL PHONE NUMBERS (to be filled in by the holder of this manual)
Immediate supervisor: ____________________________
Local R.C.M.P. or police: _________________________
Local ambulance: ________________________________
Local helicopter base: ____________________________
Local fixed wing base: ____________________________

The next of kin is to be notified by the most senior person, attached either to the Inventory Branch or to the forest region, who is available at the time of the emergency.

Because an emergency may be of news interest, withhold the names of personnel involved until you know that the next of kin has been notified. When reporting accidents by radio, use only the code numbers when referring to an injured person.

Fill in the code sheet at the end of this chapter.

1.2 AIRCRAFT AND MARINE EMERGENCY

Report to the Inventory Branch or forest region:
A. Aircraft or boat identification.
B. Names of the pilot and other personnel involved.
C. Date and time of last position report.
D. Location of the last position report.
E. Map reference, flight plan and relevant aerial photo numbers.

If you are unable to contact one of the previously listed inventory branch or forest region personnel (see Section 1.11 and 1.12), call the Operator and say "Aircraft Distress" or "Marine Distress" as the case may be. Your information will be received by the Rescue Coordination Centre.

1.21 FLARE KIT INSTRUCTIONS

A. If possible, fire from an opening or hilltop.

B. Fire the flare into the field of vision of the aircraft's occupants. It will likely be wasted on a retreating aircraft. Do not fire directly at the aircraft.
C. Fire flares at daybreak or at twilight for maximum visibility by ground parties. Search parties are unlikely to be out at night.

D. Space out your flares: at least one-half hour apart. Save at least two for the next morning.

E. Fire flares almost vertically and downhill. Watch where the flare lands in case it starts a fire.

F. STAY PUT WHEN YOU HAVE BEEN SPOTTED unless directed otherwise by searchers. See air-to-ground signals in Section 1.43.

1.3 WHEN LOST IN THE BUSH

A. Remain calm.

B. Sit down, relax and try to figure out where you are.

C. Take stock of what you have with you.

D. Go to a high point to orient yourself and to improve your chances of being spotted.

E. Do not walk yourself into a state of exhaustion; conserve energy.

F. If you have not oriented yourself by twilight, decide to spend the night in the bush. Make this decision earlier if you are exhibiting signs of exhaustion or hypothermia.

G. Prepare to spend the night by:
   1. checking instructions in the flare kit,
   2. preparing a smoke-signal fire,
   3. laying out ground-to-air signals if necessary and possible,
   4. making shelter and building a night fire, and by
   5. conserving food.

Note: Stay put when you have been spotted unless otherwise directed by the searchers.

1.4 EMERGENCY SIGNALS

1.41 RADIO CODE FOR AIR ASSISTANCE

Class A (Alpha) - Emergency. Require doctor to be flown in immediately.

Class B (Bravo) - Emergency, but no doctor required. Need air transport immediately.

Class C (Charlie) - No emergency, but require medical attention. Fly out as soon as possible.

Class D (Delta) - No medical attention required. Fly out as soon as possible.
1.42 GROUND TO AIR SIGNALS

Require doctor - serious injury.......................... I
Require medical supplies................................... II
Unable to proceed........................................... X
Require food and water........................................ F
Require map and compass.................................... O
Require radio.................................................. K
Indicate direction to proceed...............................
Am proceeding in this direction...........................
Will attempt to take off.................................
Aircraft seriously damaged............................
Require fuel and oil.......................................... L
All well......................................................... LL
No................................................................. N
Yes............................................................... Y
Not understood............................................... JL
Require engineer................................................
Drop here........................................................
Require helicopter.......................................... H

1.43 AIR TO GROUND SIGNALS

Visual signals to be used in emergencies and in fire protection work:

Circle three times, proceed to target
Low pass over drop area, revving motors
Pass or drop area, wobbling wings

In answer to ✖
Take cover: air drop coming
Finished dropping or signals recognized
1.5 BASIC FIRST AID

Remember to treat injuries in order of priority:

A. Check for breathing (see Section 1.51).
B. Stop the bleeding (see Section 1.52).
C. Treat for shock (see Section 1.5.10).
D. Immobilize fractures (see Section 1.57).

1.51 ARTIFICIAL (MOUTH-TO-MOUTH) RESUSCITATION

A. If possible place the victim on his back and clear the mouth and throat.
B. Open the airway by lifting his neck and tilting the head back.
C. Pinch his nostrils with your thumb and forefinger and, at the same time, keep pressure on his forehead with the base of the hand in order to keep the air passage open.
D. Place your mouth tightly around his mouth and initially blow forcefully four full breaths. Watch for chest expansion out of the corner of your eye.
E. Remove your mouth to allow the lungs to deflate.
F. Repeat steps C to E with one breath every five seconds.
G. DON'T GIVE UP.

1.52 BLEEDING

A. Apply direct pressure to the wound with field dressing or other available clean material.
B. Do not remove dressing if saturated, but apply another dressing on top of it.
C. Elevate the wounded area above the heart, if possible.
D. Do not remove an imbedded object, but apply pressure around it with a ring pad, and treat as in A to C.

1.53 BLISTERS

A. Alleviate pain and friction by applying a wide band of adhesive tape smoothly over - and well beyond - the margins of the "hot spot".
B. Do not break blisters.
1.54 BURNS
A. Do not remove burnt clothing.
B. Soak in cold water to relieve pain (30 minutes). **But do NOT soak third degree burns** (exposed flesh).
C. Cover with a piece of sterile gauze and bandage firmly.
D. Offer the victim more water than usual.
**Note:** Do not apply greasy substances or ointments to the burn.

1.55 DIARRHEA
A. Drink black tea, and eat bananas and cheese.
B. Avoid contamination from someone who has diarrhea by thoroughly washing shared eating utensils.

1.56 FOOD POISONING
A. Secure medical aid.
B. Preserve a sample of the suspected cause.
C. Do not induce vomiting when the casualty is unconscious, otherwise assist him to vomit.

1.57 FRACTURES (BROKEN BONES)
A. Splint the joints above and below the fracture with available stiff materials (e.g., saplings, tally sack, other parts of body, etc.).
B. Splint deformed fractures in the position found. If the fracture punctures the skin, a skilled first aid attendant may apply traction and straighten the deformity.
C. With open fractures, place a ring (donut) pad around the protruding bone and cover with clean dressing before splinting.
D. Check splint ties frequently to ensure that they do not interfere with circulation.
E. Apply cold compresses to decrease pain and swelling.
1.58 HEAT EXHAUSTION
A. Have the patient lie down in a cool place.
B. Loosen tight clothing.
C. Raise his legs slightly.
D. If conscious, give him a warm drink.
E. Put him in the 3/4-prone position.

1.59 HYPOTHERMIA
Immediate and positive treatment is required:
A. Get the victim out of the cold, wind and rain.
B. If possible, strip off all wet clothes, get him into dry clothes and into a warm sleeping bag; well-wrapped warm rocks placed near him will help (i.e., warm rocks from a nearby fire).
C. If he is conscious, give him warm drinks (non-alcoholic).
D. If he is semi-conscious or worse, try to keep him awake and give him warm drinks. If possible, strip all his clothes and put him into a sleeping bag with another person (also stripped). This skin-to-skin contact is the most effective treatment.

1.5.10 SHOCK
Prevention and treatment:
A. Loosen tight clothing.
B. Reassure the patient.
C. Keep him warm (insulate below as well as above the patient).
D. Place him in the most comfortable position.
E. Continue to reassure him.
F. Moisten his lips if thirsty (no food or drink).
G. If he is unconscious, put him in the 3/4-prone position.

1.5.11 SPRAINS
A. Simple:
   1. Wrap with elastoplast or bandage.
   2. Apply a cold compress (e.g., clothing soaked in creek water), if possible
   3. Elevate and rest the sprain when possible (e.g., during lunch break).
B. Serious:
   1. Apply cold compresses to the sprain to reduce swelling for at least 24 hours.
   2. Get medical aid.
1.5.12 UNCONSCIOUSNESS

Unconsciousness means that a person fails to react to voice or touch. Whatever the degree of unconsciousness, the victim is in extreme danger and has no way of protecting himself from choking on blood, vomit or on his tongue. Before seeking help place him in the drainage position. Gently turn him on his side, injured side down, with his cheek on the ground. Keep his chin off the chest, make sure his mouth is open and the airway straight and clear.

1.6 LEAVING AN INJURED PERSON IN THE BUSH

If you must leave your partner in the bush:

A. Make sure he is comfortable and treat all injuries before you leave. If there is a danger of his becoming unconscious, prop him in the drainage position.

B. Leave him with:
   1. Shelter, when raining or cold.
   2. Food and water.
   3. Fire, wood, kindling, matches
   5. Flare kit.
   6. Extra clothing, both over and under.
   7. Tally bag.
   8. Watch.

C. Tell him your plans:
   1. Direction and route you are taking.
   2. Estimated time of return.
   3. What you will do when you reach camp or a vehicle.
   4. Reassure him before you leave.

D. Mark his location well with flagging tape; you may have to return in the dark.

E. Flag or blaze your way out, using your compass.

F. Take air photos with you, having marked your partner's location before leaving.
<table>
<thead>
<tr>
<th>NAME</th>
<th>CODE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
FOREWORD

The British Columbia Forest Act (1978) states that the Chief Forester shall develop and maintain an inventory of the land and forests in the Province, and shall assess the land in the Province for its potential for growing trees continuously, providing forest oriented recreation, producing forage for livestock and wildlife, and for accommodating other forest uses. Also, the Ministry of Forests Act (1978) requires a periodic resource analysis report containing a description of the inventory of the forest and range resources in the Province, a description of the location and extent of areas of forest land in the Province that have been denuded of timber through harvesting or otherwise and have not become restocked with a commercially valuable species of timber, or are producing timber at the rate that is substantially lower than their potential. In addition, the Minister of Forests is required to submit to the Lieutenant-Governor in Council an annual report which must include a summary of forest land in the Province, showing areas denuded of forest during the year, areas restocked during the year and areas the productivity of which has been improved during the year.

In order to implement the requirements of the new forest legislation, the Planning and Inventory Branch of the Ministry of Forests has acquired new technology and has developed new approaches for conducting forest inventory. The Forest Inventory Manual, consisting of ten chapters, the Five-year Plan for Forest Inventory in British Columbia: 1981-1985, and the Inventory handbooks, namely the Field Handbook, the Helicopter Camera Boom Instruction and Operation Handbook, the Colour Stereogram Handbook, and the Stereocord Handbook, describe the procedures for planning, conducting and auditing provincial forest inventories.

F. HEGYI, R.P.F.
DIRECTOR
Chapter two, "Environmentally Sensitive Areas", of the Forest Inventory Manual is a description of the methods used to apply the E.S.A. Classification system to productive and unproductive forest land.

This chapter was prepared by G.E. Stenberg, R.P.F., and it was edited by A.A. Britneff, R.P.F.

For further information, please contact:

Dr. R.V. Quenet, R.P.F.
Manager
Remote Sensing and Update
## TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>INTRODUCTION</td>
<td>11</td>
</tr>
<tr>
<td>2.2</td>
<td>E.S.A. SYSTEM</td>
<td>11</td>
</tr>
<tr>
<td>2.3</td>
<td>Es - SOIL</td>
<td>15</td>
</tr>
<tr>
<td>2.31</td>
<td>PROCEDURE</td>
<td>15</td>
</tr>
<tr>
<td>2.311</td>
<td>Erosional Processes</td>
<td>15</td>
</tr>
<tr>
<td>2.312</td>
<td>Classification of Es Areas: Es1 or Es2</td>
<td>21</td>
</tr>
<tr>
<td>2.313</td>
<td>Use of Soil, Soils-and-Landforms, and Terrain Maps</td>
<td>24</td>
</tr>
<tr>
<td>2.32</td>
<td>SOURCES OF INFORMATION</td>
<td>24</td>
</tr>
<tr>
<td>2.4</td>
<td>Ep - FOREST REGENERATION</td>
<td>27</td>
</tr>
<tr>
<td>2.41</td>
<td>PROCEDURE</td>
<td>27</td>
</tr>
<tr>
<td>2.411</td>
<td>Geoclimatic Factors</td>
<td>27</td>
</tr>
<tr>
<td>2.412</td>
<td>Use of Edatopic Grids</td>
<td>31</td>
</tr>
<tr>
<td>2.413</td>
<td>Biotic Factors</td>
<td>32</td>
</tr>
<tr>
<td>2.414</td>
<td>Classification of Ep Areas: Ep1 or Ep2</td>
<td>33</td>
</tr>
<tr>
<td>2.42</td>
<td>SOURCES OF INFORMATION</td>
<td>34</td>
</tr>
<tr>
<td>2.5</td>
<td>Ea - SNOW AVALANCHE</td>
<td>36</td>
</tr>
<tr>
<td>2.51</td>
<td>PROCEDURE</td>
<td>36</td>
</tr>
<tr>
<td>2.511</td>
<td>Values to be Protected</td>
<td>36</td>
</tr>
<tr>
<td>2.512</td>
<td>Assessment of Avalanche Hazard</td>
<td>37</td>
</tr>
<tr>
<td>2.513</td>
<td>Classification of Ea Areas</td>
<td>37</td>
</tr>
<tr>
<td>2.5131</td>
<td>Starting Zone</td>
<td>39</td>
</tr>
<tr>
<td>2.5132</td>
<td>Runout Zone or End Zone</td>
<td>39</td>
</tr>
<tr>
<td>2.5133</td>
<td>Other Applications</td>
<td>41</td>
</tr>
<tr>
<td>2.52</td>
<td>SOURCES OF INFORMATION</td>
<td>41</td>
</tr>
<tr>
<td>2.6</td>
<td>Er - RECREATION</td>
<td>42</td>
</tr>
<tr>
<td>2.61</td>
<td>PROCEDURE</td>
<td>42</td>
</tr>
<tr>
<td>2.611</td>
<td>Recreational Features</td>
<td>42</td>
</tr>
<tr>
<td>2.612</td>
<td>Landscape (Visual) Features</td>
<td>44</td>
</tr>
<tr>
<td>2.613</td>
<td>Classification of Er Areas: Er1 or Er2</td>
<td>45</td>
</tr>
<tr>
<td>2.62</td>
<td>SOURCES OF INFORMATION</td>
<td>46</td>
</tr>
<tr>
<td>2.7</td>
<td>Ew - WILDLIFE</td>
<td>47</td>
</tr>
<tr>
<td>2.71</td>
<td>PROCEDURE</td>
<td>47</td>
</tr>
<tr>
<td>2.711</td>
<td>General Habitat Characteristics for Various Big Game Species</td>
<td>48</td>
</tr>
<tr>
<td>2.712</td>
<td>Classification of Ew Areas: Ew1 or Ew2</td>
<td>50</td>
</tr>
<tr>
<td>2.713</td>
<td>Mapping and Labelling</td>
<td>52</td>
</tr>
<tr>
<td>2.72</td>
<td>SOURCES OF INFORMATION</td>
<td>53</td>
</tr>
<tr>
<td>Section</td>
<td>Title</td>
<td>Page</td>
</tr>
<tr>
<td>---------</td>
<td>----------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>2.8</td>
<td>Eh - WATER</td>
<td>54</td>
</tr>
<tr>
<td>2.8.1</td>
<td>PROCEDURE</td>
<td>54</td>
</tr>
<tr>
<td>2.8.1.1</td>
<td>Water Quality, Quantity and Seasonal Distribution</td>
<td>54</td>
</tr>
<tr>
<td>2.8.1.2</td>
<td>Community Watersheds</td>
<td>55</td>
</tr>
<tr>
<td>2.8.1.3</td>
<td>Other Watersheds with High Water Values</td>
<td>56</td>
</tr>
<tr>
<td>2.8.1.4</td>
<td>Watershed Planning</td>
<td>56</td>
</tr>
<tr>
<td>2.8.1.5</td>
<td>Classification of Eh Areas: Eh1 or Eh2</td>
<td>57</td>
</tr>
<tr>
<td>2.8.2</td>
<td>SOURCES OF INFORMATION</td>
<td>58</td>
</tr>
<tr>
<td>2.9</td>
<td>FISHERIES</td>
<td>59</td>
</tr>
<tr>
<td>2.9.1</td>
<td>PROCEDURE</td>
<td>59</td>
</tr>
<tr>
<td>2.9.1.1</td>
<td>Stream Value for Fisheries</td>
<td>59</td>
</tr>
<tr>
<td>2.9.1.2</td>
<td>Stream Sensitivity to Disturbance</td>
<td>60</td>
</tr>
<tr>
<td>2.9.1.3</td>
<td>Fisheries-value and Stream-sensitivity Ratings</td>
<td>61</td>
</tr>
<tr>
<td>2.9.2</td>
<td>SOURCES OF INFORMATION</td>
<td>62</td>
</tr>
<tr>
<td>2.10</td>
<td>E.S.A. FIELD PROCEDURES</td>
<td>63</td>
</tr>
<tr>
<td>2.10.1</td>
<td>E.S.A. FIELD WORK FROM THE AIR</td>
<td>63</td>
</tr>
<tr>
<td>2.10.1.1</td>
<td>Selection of Photo Scale</td>
<td>63</td>
</tr>
<tr>
<td>2.10.1.2</td>
<td>Types of Flight Plan</td>
<td>63</td>
</tr>
<tr>
<td>2.10.1.3</td>
<td>Flight Plan Preparation</td>
<td>64</td>
</tr>
<tr>
<td>2.10.1.4</td>
<td>Flight Procedures</td>
<td>65</td>
</tr>
<tr>
<td>2.10.1.5</td>
<td>Post-flight Procedure</td>
<td>67</td>
</tr>
<tr>
<td>2.10.2</td>
<td>E.S.A. FIELD WORK FROM THE GROUND OR WATER</td>
<td>67</td>
</tr>
<tr>
<td>2.10.3</td>
<td>GROUND SAMPLES AND CLASSIFICATION GROUND CALLS AND AIR CALLS</td>
<td>69</td>
</tr>
<tr>
<td>2.10.4</td>
<td>DOCUMENTATION OF E.S.A. FIELD WORK</td>
<td>69</td>
</tr>
<tr>
<td>2.11</td>
<td>E.S.A. LABELS AND SYMBOLS</td>
<td>70</td>
</tr>
<tr>
<td>2.11.1</td>
<td>LABELLING</td>
<td>70</td>
</tr>
<tr>
<td>2.11.2</td>
<td>FISHERIES SYMBOLS</td>
<td>72</td>
</tr>
<tr>
<td>2.12</td>
<td>E.S.A. REPORT</td>
<td>76</td>
</tr>
<tr>
<td>2.13</td>
<td>UPDATING OF ENVIRONMENTAL CLASSIFICATIONS</td>
<td>79</td>
</tr>
<tr>
<td>2.13.1</td>
<td>INSTRUCTIONS</td>
<td>81</td>
</tr>
<tr>
<td>2.13.2</td>
<td>UPDATING BY YEAR OF ENVIRONMENTAL SURVEY</td>
<td>82</td>
</tr>
<tr>
<td>2.13.2.1</td>
<td>1973-to-1975 E.P.F.s</td>
<td>82</td>
</tr>
<tr>
<td>2.13.2.2</td>
<td>1976 E.P.A.s</td>
<td>82</td>
</tr>
<tr>
<td>2.13.2.3</td>
<td>1977 E.P.A.s</td>
<td>83</td>
</tr>
<tr>
<td>2.13.2.4</td>
<td>1978 E.P.A.s</td>
<td>83</td>
</tr>
<tr>
<td>2.13.2.5</td>
<td>1979-to-1980 E.P.A.s</td>
<td>84</td>
</tr>
<tr>
<td>2.13.2.6</td>
<td>1981-to-1982 E.P.A.s</td>
<td>84</td>
</tr>
<tr>
<td></td>
<td>APPENDICES</td>
<td>85</td>
</tr>
</tbody>
</table>
# CHAPTER TWO
ENVIROMENTALLY SENSITIVE AREAS

## LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-1</td>
<td>Avalanche path: starting zone, track, and runout zone</td>
<td>37</td>
</tr>
<tr>
<td>2-2</td>
<td>Protection buffer in avalanche starting zone</td>
<td>39</td>
</tr>
<tr>
<td>2-3</td>
<td>Runout zone - no protection required</td>
<td>40</td>
</tr>
<tr>
<td>2-4</td>
<td>Forests used as avalanche buffers</td>
<td>40</td>
</tr>
<tr>
<td>2-5</td>
<td>Grizzly bear symbols along salmon streams</td>
<td>53</td>
</tr>
<tr>
<td>2-6</td>
<td>Fisheries symbols</td>
<td>62</td>
</tr>
<tr>
<td>2-7</td>
<td>E.S.A. flight plan photo (1:63 360)</td>
<td>66</td>
</tr>
<tr>
<td>2-8</td>
<td>E.S.A. flight plan photo (1:63 360) with recorded information</td>
<td>68</td>
</tr>
<tr>
<td>2-9</td>
<td>Grizzly bear symbols along salmon streams</td>
<td>71</td>
</tr>
<tr>
<td>2-10</td>
<td>Forest types separated by different E.S.A.'s only</td>
<td>71</td>
</tr>
<tr>
<td>2-11</td>
<td>Placement of fisheries symbols along streams</td>
<td>73</td>
</tr>
<tr>
<td>2-12</td>
<td>One fisheries symbol across an entire map sheet</td>
<td>74</td>
</tr>
<tr>
<td>2-13</td>
<td>Different fisheries symbols along a stream</td>
<td>74</td>
</tr>
<tr>
<td>2-14</td>
<td>Tying of fisheries symbols to adjoining maps</td>
<td>74</td>
</tr>
<tr>
<td>2-15</td>
<td>Fisheries symbols where streams enter and leave lakes</td>
<td>75</td>
</tr>
<tr>
<td>2-16</td>
<td>Fisheries symbols where streams widen</td>
<td>75</td>
</tr>
<tr>
<td>2-17</td>
<td>Fisheries symbols for side channels and back channels</td>
<td>75</td>
</tr>
<tr>
<td>2-18</td>
<td>Removal of unnecessary E.P.F. or E.P.A. lines</td>
<td>81</td>
</tr>
<tr>
<td>2-19</td>
<td>Debris slide</td>
<td>93</td>
</tr>
<tr>
<td>2-20</td>
<td>Block glide (lateral spread)</td>
<td>93</td>
</tr>
<tr>
<td>2-21</td>
<td>Debris avalanche</td>
<td>94</td>
</tr>
<tr>
<td>2-22</td>
<td>Debris flow</td>
<td>95</td>
</tr>
<tr>
<td>2-23</td>
<td>Sand or silt flow</td>
<td>95</td>
</tr>
<tr>
<td>2-24</td>
<td>Earthflow</td>
<td>95</td>
</tr>
<tr>
<td>2-25</td>
<td>Loess flow (dry)</td>
<td>96</td>
</tr>
<tr>
<td>2-26</td>
<td>Rapid earthflow of wet soil</td>
<td>96</td>
</tr>
<tr>
<td>2-27</td>
<td>Process of degradation</td>
<td>97</td>
</tr>
<tr>
<td>2-28</td>
<td>Forces acting on a block on an inclined plane</td>
<td>100</td>
</tr>
<tr>
<td>2-29</td>
<td>Terms applied to parts of a landslide</td>
<td>101</td>
</tr>
<tr>
<td>2-30</td>
<td>Rotational slump in bedrock: slow to moderate movement</td>
<td>101</td>
</tr>
<tr>
<td>2-31</td>
<td>Combined slump and earthflow involving rotational slump of bedrock and soil</td>
<td>102</td>
</tr>
<tr>
<td>2-32</td>
<td>Relationship between angles in degrees and in percent</td>
<td>104</td>
</tr>
<tr>
<td>2-33</td>
<td>Snow erosion from acceleration zones and redeposition in deceleration zones</td>
<td>110</td>
</tr>
<tr>
<td>2-34</td>
<td>Snow avalanche zones</td>
<td>111</td>
</tr>
<tr>
<td>2-35</td>
<td>Bed surface inclinations</td>
<td>113</td>
</tr>
<tr>
<td>2-36</td>
<td>Avalanche tracks</td>
<td>113</td>
</tr>
<tr>
<td>2-37</td>
<td>Changes in age and species composition</td>
<td>115</td>
</tr>
</tbody>
</table>
CHAPTER TWO
ENVIRONMENTALLY SENSITIVE AREAS

LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-1</td>
<td>Avalanche path: starting zone, track, and runout zone</td>
<td>37</td>
</tr>
<tr>
<td>2-2</td>
<td>Protection buffer in avalanche starting zone</td>
<td>39</td>
</tr>
<tr>
<td>2-3</td>
<td>Runout zone - no protection required</td>
<td>40</td>
</tr>
<tr>
<td>2-4</td>
<td>Forests used as avalanche buffers</td>
<td>40</td>
</tr>
<tr>
<td>2-5</td>
<td>Grizzly bear symbols along salmon streams</td>
<td>53</td>
</tr>
<tr>
<td>2-6</td>
<td>Fisheries symbols</td>
<td>62</td>
</tr>
<tr>
<td>2-7</td>
<td>E.S.A. flight plan photo (1:63 360)</td>
<td>66</td>
</tr>
<tr>
<td>2-8</td>
<td>E.S.A. flight plan photo (1:63 360) with recorded information</td>
<td>68</td>
</tr>
<tr>
<td>2-9</td>
<td>Grizzly bear symbols along salmon streams</td>
<td>71</td>
</tr>
<tr>
<td>2-10</td>
<td>Forest types separated by different E.S.A.s only</td>
<td>71</td>
</tr>
<tr>
<td>2-11</td>
<td>Placement of fisheries symbols along streams</td>
<td>73</td>
</tr>
<tr>
<td>2-12</td>
<td>One fisheries symbol across an entire map sheet</td>
<td>74</td>
</tr>
<tr>
<td>2-13</td>
<td>Different fisheries symbols along a stream</td>
<td>74</td>
</tr>
<tr>
<td>2-14</td>
<td>Tying of fisheries symbols to adjoining maps</td>
<td>74</td>
</tr>
<tr>
<td>2-15</td>
<td>Fisheries symbols where streams enter and leave lakes</td>
<td>75</td>
</tr>
<tr>
<td>2-16</td>
<td>Fisheries symbols where streams widen</td>
<td>75</td>
</tr>
<tr>
<td>2-17</td>
<td>Fisheries symbols for side channels and back channels</td>
<td>75</td>
</tr>
<tr>
<td>2-18</td>
<td>Removal of unnecessary E.P.F. or E.P.A. lines</td>
<td>81</td>
</tr>
<tr>
<td>2-19</td>
<td>Debris slide</td>
<td>93</td>
</tr>
<tr>
<td>2-20</td>
<td>Block glide (lateral spread)</td>
<td>93</td>
</tr>
<tr>
<td>2-21</td>
<td>Debris avalanche</td>
<td>94</td>
</tr>
<tr>
<td>2-22</td>
<td>Debris flow</td>
<td>95</td>
</tr>
<tr>
<td>2-23</td>
<td>Sand or silt flow</td>
<td>95</td>
</tr>
<tr>
<td>2-24</td>
<td>Earthflow</td>
<td>95</td>
</tr>
<tr>
<td>2-25</td>
<td>Loess flow (dry)</td>
<td>96</td>
</tr>
<tr>
<td>2-26</td>
<td>Rapid earthflow of wet soil</td>
<td>96</td>
</tr>
<tr>
<td>2-27</td>
<td>Process of degradation</td>
<td>97</td>
</tr>
<tr>
<td>2-28</td>
<td>Forces acting on a block on an inclined plane</td>
<td>100</td>
</tr>
<tr>
<td>2-29</td>
<td>Terms applied to parts of a landslide</td>
<td>101</td>
</tr>
<tr>
<td>2-30</td>
<td>Rotational slump in bedrock: slow to moderate movement</td>
<td>101</td>
</tr>
<tr>
<td>2-31</td>
<td>Combined slump and earthflow involving rotational slump</td>
<td>102</td>
</tr>
<tr>
<td>2-32</td>
<td>Relationship between angles in degrees and in percent</td>
<td>104</td>
</tr>
<tr>
<td>2-33</td>
<td>Snow erosion from acceleration zones and redeposition in deceleration zones</td>
<td>110</td>
</tr>
<tr>
<td>2-34</td>
<td>Snow avalanche zones</td>
<td>111</td>
</tr>
<tr>
<td>2-35</td>
<td>Bed surface inclinations</td>
<td>113</td>
</tr>
<tr>
<td>2-36</td>
<td>Avalanche tracks</td>
<td>113</td>
</tr>
<tr>
<td>2-37</td>
<td>Changes in age and species composition</td>
<td>115</td>
</tr>
</tbody>
</table>
CHAPTER TWO
ENVIRONMENTALLY SENSITIVE AREAS

LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-1</td>
<td>E.S.A. categories and classes</td>
<td>14</td>
</tr>
<tr>
<td>2-2</td>
<td>Mass movement types by rate of movement</td>
<td>17</td>
</tr>
<tr>
<td>2-3</td>
<td>Avalanche hazard rating</td>
<td>38</td>
</tr>
<tr>
<td>2-4</td>
<td>Symbols for wildlife species</td>
<td>52</td>
</tr>
<tr>
<td>2-5</td>
<td>Fisheries-value and stream-sensitivity ratings and fisheries symbols</td>
<td>61</td>
</tr>
<tr>
<td>2-6</td>
<td>Fisheries symbol matrix</td>
<td>61</td>
</tr>
<tr>
<td>2-7</td>
<td>Symbols for E.S.A. categories</td>
<td>70</td>
</tr>
<tr>
<td>2-8</td>
<td>Symbols for wildlife species</td>
<td>70</td>
</tr>
<tr>
<td>2-9</td>
<td>Fisheries-value and stream-sensitivity ratings and fisheries symbols</td>
<td>73</td>
</tr>
<tr>
<td>2-10</td>
<td>Colour codes by E.S.A. category for summary map</td>
<td>78</td>
</tr>
<tr>
<td>2-11</td>
<td>1973-to-1975 E.P.F. categories</td>
<td>79</td>
</tr>
<tr>
<td>2-12</td>
<td>1976 E.P.A. categories</td>
<td>80</td>
</tr>
<tr>
<td>2-13</td>
<td>Conversion of 1976-to-1977 fisheries symbols</td>
<td>83</td>
</tr>
<tr>
<td>2-14</td>
<td>Classification of landslides, abbreviated version</td>
<td>92</td>
</tr>
<tr>
<td>2-15</td>
<td>List of indicator plants for the ESSFb subzone</td>
<td>106</td>
</tr>
<tr>
<td>2-16</td>
<td>Vegetation as a rough indicator of avalanche frequency</td>
<td>115</td>
</tr>
</tbody>
</table>

LIST OF APPENDICES

<table>
<thead>
<tr>
<th>Appendix</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-1</td>
<td>Movement of surficial materials by gravity</td>
<td>87</td>
</tr>
<tr>
<td>2-2</td>
<td>Slope conversion chart</td>
<td>104</td>
</tr>
<tr>
<td>2-3</td>
<td>Edatopic grid and ecosystem associations with indicator plants for the ESSFb biogeoclimatic subzone</td>
<td>105</td>
</tr>
<tr>
<td>2-4</td>
<td>Snow avalanche areas</td>
<td>108</td>
</tr>
<tr>
<td>2-5</td>
<td>Community watershed objectives and management guidelines</td>
<td>117</td>
</tr>
<tr>
<td>2-6</td>
<td>E.S.A. assessment form (F.S. 804)</td>
<td>121</td>
</tr>
<tr>
<td>2-7</td>
<td>Year of classification for environmental sensitivity by unit</td>
<td>129</td>
</tr>
</tbody>
</table>
CHAPTER TWO
ENVIRONMENTALLY SENSITIVE AREAS

2.1 INTRODUCTION

Not all forest land is available for sustained timber production. Some areas are environmentally sensitive and/or significantly valuable for other resources: for example, stands growing on excessively steep sidehills or on unstable soils where slides or excessive soil erosion may occur after logging; fragile sites where the establishment of a second crop may prove to be unsuccessful or much delayed if present logging practices were allowed; areas where harvesting may cause snow avalanches that could destroy man-made structures or valuable natural resources; and areas on which an equal or higher value on other resources such as recreation, wildlife, water and fish may be placed. These areas are identified and delineated during a forest inventory and are called environmentally sensitive areas (E.S.A.).

E.S.A.s reflect the environmental, technological, social and economic constraints in force at the time of inventory. They are designed to supplement a resource database that is necessary for integrated forest management at several levels of planning intensity.

2.2 E.S.A. SYSTEM

The objectives of the E.S.A. classification system are:

A. To identify, for forest management, areas that are environmentally sensitive or have values for other resources, specifically:

1. Areas having actual or potential, fragile or unstable soils that may deteriorate unacceptably after harvesting.

2. Areas having actual or potential severe regeneration problems.

3. Areas providing protection to man-made structures and valuable natural resources from snow avalanches.

4. Areas having significant value for recreational activity or viewing enjoyment.

5. Areas having high value to wildlife for food, shelter or reproduction.

6. Watersheds, or portions thereof, having high value for consumptive use where water quality, quantity and seasonal distribution are very important.
2.2 cont.

B. To identify the importance of streams, or stream reaches, to fish and the sensitivity of streams to forest harvesting.

C. To provide site-specific data on environmental sensitivity and on other resource values for consideration by forest planners and managers in the determination of the rate, location and timing of timber harvesting.

Environmentally sensitive areas are considered only when there is evidence that the contribution of the area to the timber harvest may be severely limited, or where special management and harvesting prescriptions and/or constraints are required. The application of appropriate management, harvesting and other prescriptions that ensure protection of both the land base and other resource values may result in areas designated as E.S.A.s being made available for harvesting.

All E.S.A. categories may also be applied to unproductive forest land (alpine forest and non-productive forest) and only the recreation, wildlife and water E.S.A. categories may be applied to non-forest land, when justified.

The E.S.A. classification system recognizes these E.S.A. categories: soil (Es), forest regeneration (Ep), snow avalanche (Ea), recreation (Er), wildlife (Ew), water (Eh), and fisheries (fisheries symbols). For details on the procedures for designation of, and the sources of information for, each E.S.A. category, refer to Sections 2.3 to 2.9.

For each E.S.A. category (except snow avalanche and fisheries), two E.S.A. classes are recognized: high and moderate, which are denoted by the subscripts 1 and 2, respectively (Es1, Ep1, Er1, Ew1, Eh1 and Es2, Ep2, Er2, Ew2, Eh2, respectively).

**High E.S.A. Class**

The high E.S.A. class is applied to forest land that is highly sensitive and/or highly valuable for other resources and is not normally available for sustained timber production.

**Moderate E.S.A. Class**

The moderate E.S.A. class is applied to forest land that is moderately sensitive or moderately valuable for other resources and is available for sustained timber production only under special management considerations.

For the snow avalanche category (Ea) only the high E.S.A. class is recognized.

For the fisheries category, four fisheries-value and stream-sensitivity ratings (nil, low, moderate and high) are recognized. These ratings are derived from a fisheries matrix and are denoted by fisheries symbols (see Section 2.913).
The E.S.A. categories, E.S.A. classes and stream ratings, and their respective symbols, are shown in Table 2-1. For further information on E.S.A. labels and symbols, see Section 2.11.

E.S.A.s are identified through photo interpretation, ground investigation, low-level helicopter flights, and data provided by other resource agencies and public interest groups. For more details on E.S.A. field procedures, reports and updating, refer to sections 2.10., 2.12. and 2.13., respectively.
### Table 2-1

**E.S.A. categories and classes**

<table>
<thead>
<tr>
<th>E.S.A. Category</th>
<th>Symbol</th>
<th>E.S.A. Class or Stream Rating</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Soil</strong></td>
<td>E₁</td>
<td>High</td>
<td>Areas having extremely fragile or unstable soils.</td>
</tr>
<tr>
<td></td>
<td>E₂</td>
<td>Moderate</td>
<td>Areas having significantly fragile or unstable soils but less than those for E₁.</td>
</tr>
<tr>
<td><strong>Forest regeneration</strong></td>
<td>E₁</td>
<td>High</td>
<td>Areas having severe regeneration problems caused by geoclimatic factors.</td>
</tr>
<tr>
<td></td>
<td>E₂</td>
<td>Moderate</td>
<td>Areas having severe regeneration problems caused by biotic factors.</td>
</tr>
<tr>
<td><strong>Snow avalanche</strong></td>
<td>Eₐ</td>
<td>High</td>
<td>Areas having severe snow chute and avalanche problems.</td>
</tr>
<tr>
<td><strong>Recreation</strong></td>
<td>E₁</td>
<td>High</td>
<td>Areas having exceptionally high recreational values.</td>
</tr>
<tr>
<td></td>
<td>E₂</td>
<td>Moderate</td>
<td>Areas having high recreational values but less than those for E₁.</td>
</tr>
<tr>
<td><strong>Wildlife</strong></td>
<td>E₁</td>
<td>High</td>
<td>Areas having critical importance to wildlife.</td>
</tr>
<tr>
<td></td>
<td>E₂</td>
<td>Moderate</td>
<td>Areas having high value for wildlife, but less than that for E₁.</td>
</tr>
<tr>
<td><strong>Water</strong></td>
<td>E₁</td>
<td>High</td>
<td>Areas having very high water values and extreme sensitivity to harvesting.</td>
</tr>
<tr>
<td></td>
<td>E₂</td>
<td>Moderate</td>
<td>Areas having very high water values and high sensitivity but less sensitivity than that for E₁.</td>
</tr>
<tr>
<td><strong>Fisheries</strong></td>
<td>▲</td>
<td>Nil</td>
<td>Streams or stream reaches having a nil fisheries-value and stream-sensitivity rating.</td>
</tr>
<tr>
<td></td>
<td>■</td>
<td>Low</td>
<td>Streams or stream reaches having a low fisheries-value and stream-sensitivity rating.</td>
</tr>
<tr>
<td></td>
<td>○</td>
<td>Moderate</td>
<td>Streams or stream reaches having a moderate fisheries-value and stream-sensitivity rating.</td>
</tr>
<tr>
<td></td>
<td>▼</td>
<td>High</td>
<td>Streams or stream reaches having a high fisheries-value and stream-sensitivity rating.</td>
</tr>
</tbody>
</table>

**Notes:**
1. Forest land in the high E.S.A. class is not normally available for sustained timber production.
2. Forest land in the moderate E.S.A. class is available for sustained timber production only under special management considerations.
3. Forest land not having an E.S.A. designation is subject only to operational constraints consistent with the policies of the Forest Region.
4. Unclassified streams or stream reaches are not assigned a fisheries symbol.
Erosion is the wearing away of the land surface by detachment and transportation of earth materials by running water, ground water, waves and currents, wind, glaciers, and by gravity. To recognize Es areas, it is necessary to understand certain erosional processes (geomorphological processes) and to predict how forest harvesting will affect them.

2.31 EROSION

Erosion is the wearing away of the land surface by detachment and transportation of earth materials by running water, ground water, waves and currents, wind, glaciers, and by gravity. To recognize Es areas, it is necessary to understand certain erosional processes (geomorphological processes) and to predict how forest harvesting will affect them.

2.31.1 Erosional Processes

The erosional processes that may be affected significantly by forest harvesting are deflation, surface erosion, karst, piping and mass movement.

Deflation (erosion by wind)

Deflation is the removal of sand, silt and organic particles from non-cohesive sediments by wind. Accumulation of materials transported and deposited by wind are called eolian landforms. Those resulting from the accumulation of sand and of silt are known as dunes and loess, respectively.

Surface Erosion (erosion by flowing water)

Surface erosion is the detachment and transportation of soil particles by overland flow of water or by water running in channels.

2.3 ES - SOIL

Object

The Es category identifies areas having actual or potential, fragile or unstable soils that may deteriorate unacceptably after forest harvesting.

E.S.A. Class

The two E.S.A. classes for soil are high and moderate:

A. High (Es1)

Apply this E.S.A. class to areas having extremely fragile or unstable soils. Harvesting is likely to be severely limited in these areas because it would lead to unacceptable site deterioration.

B. Moderate (Es2)

Apply this E.S.A. class to areas having significantly fragile or unstable soils but less than those designated as Es1. Harvesting is conditional in these areas.
The principal types of surface erosion are:

1. Sheet erosion, which is erosion by sheets of running water.

2. Rill erosion, which is the formation of shallow channels by running water.

3. Gully erosion (gullying), which is the formation of long, narrow depressions by concentrations of running water.

Gullies are much smaller than valleys, but larger than rills. Gully types can be classified on the basis of cross-section. For example, V-shaped gullies are formed in materials that are eroded easily and U-shaped gullies are formed in materials that are more cohesive and resistant to erosion.

Karst Processes

Karst processes are associated with the development of subterranean cavities and tunnels through the erosion of limestone, dolomite, gypsum and other soluble bedrock and may result in collapse and subsidence of the ground surface (sink holes and depressions).

Piping

Piping is subterranean erosion of unconsolidated materials by flowing water that results in the formation of tubular underground conduits. Collapse above these conduits causes small circular depressions in the land surface.

Examples of landforms, landform features and surficial materials that are susceptible to excessive erosion by these processes are:

- Some eolian, fluvial or lacustrine deposits of fine sand and silt (erosion by wind or water).

- Sites with dry, shallow soils (less than 30 cm) with bedrock frequently exposed (50% +). Examples are hilltops and ridges that lose organic and mineral soil (erosion by water, wind and gravity).

- Sites on steep topography with very thin soils (erosion by water and gravity). Examples are:
  - Very steep, broken sites such as cliffs, bluffs and narrow ledges.
  - Colluvial, fragmented materials (large boulders and few fines).
  - Lower margins of talus slopes.

- Faces and edges of outwash terraces (erosion by water).
- Lacustrine deposits of silt and sand adjacent to established drainage patterns (erosion by water).

- Areas with water-soluble bedrock such as limestone, dolomite, and gypsum (karst processes).

- Lacustrine materials and associated colluvial silts, and some tills and debris flow deposits (piping).

**Mass Movement**

Mass movement is the downslope movement of earth materials owing to the force of gravity. Most mass movements are associated with high soil moisture and steep slopes. Local bedrock types, climate, and soil characteristics are also determinants of mass movement.

The rate of mass movement ranges from slow but continuous to rapid and possibly repetitive. For example, soil creep is a very slow process, whereas rockfall is a very rapid one. A few other mass movements may be either slow or rapid such as slumps. Table 2-2 is a classification of mass movement types by rate of movement (see 'Terrain Classification System - Revision', see Section 2.32 B.3).

<table>
<thead>
<tr>
<th>Type of Mass Movement</th>
<th>Rate of Movement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil creep</td>
<td>Slow</td>
</tr>
<tr>
<td>Rock creep</td>
<td></td>
</tr>
<tr>
<td>Tension cracks</td>
<td></td>
</tr>
<tr>
<td>Lateral spread</td>
<td></td>
</tr>
<tr>
<td>Earthflow</td>
<td>Slow or rapid</td>
</tr>
<tr>
<td>Slump</td>
<td></td>
</tr>
<tr>
<td>Slump-earthflow</td>
<td></td>
</tr>
<tr>
<td>Debris fall</td>
<td>Rapid</td>
</tr>
<tr>
<td>Debris slide</td>
<td></td>
</tr>
<tr>
<td>Debris avalanche</td>
<td></td>
</tr>
<tr>
<td>Debris flow</td>
<td></td>
</tr>
<tr>
<td>Debris torrent</td>
<td></td>
</tr>
<tr>
<td>Rockfall</td>
<td></td>
</tr>
<tr>
<td>Rockslide</td>
<td></td>
</tr>
</tbody>
</table>

1 Mass movement types that are likely to be affected by forest harvesting.
2.311 cont.

Snow avalanche areas are also grouped with mass movement processes in the 'Terrain Classification System' used by the Ministry of Environment. However, in the E.S.A. classification system, snow avalanches are considered separately under the Ea category (snow avalanche areas) and not under the Es category.

A. Types of slow mass movement

Slow mass movement is the slow downslope movement of masses of cohesive or non-cohesive unconsolidated or bedrock material by creeping, flowing or sliding.

1. Soil creep

Soil creep is the slow downslope movement of soil.

2. Rock creep

Rock creep is the slow downslope movement of masses of angular debris due to deformation of interstitial ice.

3. Tension cracks

Tension cracks are open fissures in either bedrock or unconsolidated material resulting from tensional stresses induced by gravity.

4. Lateral spreads

Lateral spreads are lateral extension movements in a fractured mass of bedrock or unconsolidated materials; movement is dominantly horizontal.

B. Types of rapid mass movement

Rapid mass movement is the rapid downslope movement of dry, moist or saturated debris by falling, bouncing, rolling, sliding or flowing.

1. Debris fall

Debris fall is a mass of unconsolidated material detached from a steep slope and descending mostly through the air by free fall, bouncing and rolling.

2. Debris slide

Debris slide is the rapid downslope movement of unsaturated, unconsolidated material along a well-defined slip plane. The material disintegrates or is severely deformed while in motion.
2.311 cont.

3. Debris avalanche
Debris avalanche is the rapid downslope flow of masses of saturated, unconsolidated debris on steep slopes.

4. Debris flow (includes mud flow)
Debris flow is a flow of saturated debris that possesses a high degree of fluidity. Flow is typically at a rate of a few metres per second.

5. Debris torrent
Debris torrent is the rapid flow of a slurry containing rock fragments and vegetative debris along a steep, well-defined stream channel.

6. Rockfall
Rockfall is a mass of disintegrating bedrock detached from a steep slope and descending mostly through the air by bouncing and rolling.

7. Rockslide
Rockslide is the rapid downslope movement of a mass of bedrock along a well-defined slip plane. The moving mass disintegrates or is severely deformed.

C. Types of slow or rapid mass movement

1. Earthflow
Earthflow is the viscous flow of unconsolidated material containing a high portion of silt and clay.

2. Slump
Slump is the sliding of an internally cohesive mass of unconsolidated material or rock along a surface of rupture.

3. Slump-earthflow
Slump-earthflow is a combination of slump (upper part) and earthflow (lower part).

Soils Favoring a High Incidence of Mass Movement
Soils favouring a high incidence of mass movement (particularly on steeper slopes with a high moisture content) are:

- Non-cohesive soils or those soils with a low clay content and a correspondingly low frictional resistance.
- Permeable, shallow soils overlying an impermeable till or bedrock.
- Soils consisting of mainly silts and uplifted marine clays.
- Soils derived from shales, serpentine, siltstones, claystones, nonsiliceous sandstones, and pyroclastics (volcanic rocks).

**Surface Features Indicating Mass Movement**

A. Surface features indicating actual or potential mass movement which may be recognized on mid-scale aerial photographs are:

- Steep slopes having masses of loose soil and rock.
- Scars from debris avalanches, debris flows, slumps or earthflows. The severity of the problem is indicated by the size and frequency of past disturbances.
- Undercutting of cliffs and banks by streams or waves.
- Escarpments, which are often crescent-shaped and sometimes occur as a series of parallel breaks in the slope.
- Tension cracks.
- Hummocky ground and other unnatural topography.
- Topography that collects surface and subsurface water such as deeply incised ravines and V-shaped gullies.
- Closely spaced drainage channels.

B. Surface features indicating actual or potential mass movement but not easily recognized on mid-scale aerial photographs are:

- Tilted or bowed trees and displaced man-made structures.
- Ecosystem types and plant indicators of moisture: for example, cedar-skunk cabbage on a steep slope.
- Certain features of soil morphology: for example, buried horizons or discontinuity of the humus layer.
- Escape of muddy water from springs at the bases of potential slides.
- Surfaces or planes of weaknesses, such as faults, joints, bedding planes, and foliation.
2.312 Classification of Es Areas: Es1 or Es2

Es sites are selected through the interpretation of air photos, supported by air and/or ground examination where practicable. Guidance from soil and terrain specialists that have local knowledge and, where available, use of soil, soils and landforms, and terrain maps for interpreting soil stability are recommended.

Identify areas of actual and potential excessive wind or water erosion and/or mass movement. Only consider sites where forest harvesting could lead to unacceptable site deterioration for Es areas.

Unacceptable site deterioration includes:

- Severe lowering of site productivity owing to the removal of soil necessary for plant growth.
- Extreme delay in the re-establishment of protective vegetation and forest cover.
- Long-term loss of the productive land base.
- Severe lowering of the quality of downstream water and degradation of fisheries habitats.

Before we list areas for consideration as Es1 and as Es2, remember that soil stability is dependent on many factors (climate, soil moisture, soil depth, soil texture, slope gradient, slope position, slope form, bedrock geology, vegetation) and the criteria for defining potentially unstable areas vary from drainage to drainage as do these factors. However, soils and terrain specialists can usually define physiographic regions where the method of deposition of surficial materials, the landforms, and the climate, are approximately the same. Within these physiographic regions, erosion hazards should be fairly consistent. Critical slope angles and susceptible terrain are listed with the understanding that surface erosion and mass movement can occur in almost any terrain if the conditions are right.

Areas for Consideration as Es1

Sites designated as Es1 should have actual or extreme potential for wind or water erosion and/or mass movement where harvesting will not normally be permitted because it would lead to unacceptable site deterioration.

A. Wind and water erosion

1. Sites with visible evidence of significant wind erosion, sheet erosion, channel erosion (rilling and gullyng), karst processes or piping.
2. Sites with extreme potential for erosion. Include sites with geological characteristics (slope gradient, slope form, surficial materials, texture, drainage, bedrock) that are very similar to those having visible evidence of erosion in the same area. Examples are:

a) Eolian deposits.
b) Sites with dry, shallow soils (less than 30 cm) with frequent bedrock exposure (50% +).
c) Sites on steep topography (70% +, 35° +) with very thin soils.
d) Faces and edges of outwash terraces and kame terraces.
e) Colluvial or fluvial fans.

B. Mass movement

1. Sites with visible evidence of mass movement (active or historic)

a) Slopes showing soil creep, which is indicated by small scarps and tension cracks across a slope and by tilted or bowed trees and displaced man-made structures.
b) Areas having tension cracks and lateral spreads.
c) Areas with slumps and flows. Delineate the complete terrain unit associated with deep-seated slumps and flows as ES1.
d) Areas with debris slides, debris avalanches, debris flows (characterized by visible scars). Designate the terrain associated with the initial failure zones as ES1.
e) Steep, gullied terrain associated with distinct fan deposits (debris torrents).

2. Sites with extreme potential for mass movement

Include sites with geological characteristics (slope gradient, slope form, surficial materials, texture, drainage, bedrock) that are similar to those having visible evidence of mass movement in the same area. Also, include sites having a history of severe deterioration after forest harvesting. Examples of sites with extreme potential for mass movement are:

a) Steep, colluvial slopes (70% +, 35° +) having continuous movement of surficial material such as dry ravel, dry creep and sliding. All of these involve downslope movement of single particles and/or thin sheets of coarse material which lacks cohesion on sparsely vegetated slopes. The more extreme problems with steep, colluvial slopes occur on south to southwest exposures.
b) Steep slopes (70% +, 350 +) having a thin blanket of loose till over an impermeable layer of compacted till or bedrock with a smooth sliding plane parallel to the surface.

c) Faces of outwash and kame terraces.

d) Steep stream banks consisting of lacustrine deposits (silts, clays).

e) Steep stream edges and gullies associated with unconsolidated material (till, colluvium).

f) Marine deposits (sensitive clays).

Areas for Consideration as Es₂

Sites designated as Es₂ should have significant potential for wind or water erosion and/or mass movement where conditions on harvesting (road construction, logging method, logging season) are required to prevent unacceptable site deterioration.

Consider these areas for designation as Es₂

A. Sites adjacent to actual or potential Es₁ areas having the potential to start active mass movement or erosion.

B. Down slope positions of sites with extreme potential (Es₁ areas) for mass movement. Landslides may traverse Es₂ areas but should not originate within them.

C. Uniform, moderately steep, colluvial slopes (60% to 70%, 310 to 350°). These slopes are usually in the upper landscapes.

D. Uniform, moderate to steep slopes (40% to 70%, 220 to 350°) on medium and fine textured morainal and highly weathered bedrock deposits. These slopes are usually in the middle to upper landscapes.

E. Areas with numerous pockets of wet soils or seepage areas and/or areas with common inclusions of steep topography, V-shaped gullies or exposed bedrock where some harvesting will be permitted. The problems of instability on these areas are not severe enough to warrant an Es₁ designation.

F. Sites with non-cohesive materials on moderately steep slopes close to watercourses.

G. Areas with significant potential for collapse and subsidence of the ground surface owing to underground erosion. Include areas of carbonate or other water-soluble rocks (karst processes) and fine-textured lacustrine materials (piping).
Use of Soil, Soils-and-Landforms, and Terrain Maps

Soil, soils-and-landforms, and terrain maps at a scale of 1:50 000 are available for portions of British Columbia from the Surveys and Resource Mapping Branch of the Ministry of Environment. These maps can be used to determine hazard ratings for slope failure and surface erosion for various landscapes. From these hazard ratings, potential ES areas can be identified which can be verified through photo interpretation and field examination.

Terrain maps, slope stability hazard maps, and geotechnical reports are available at a scale of 1:20 000 for some sensitive development areas in the coastal forest regions. These maps and reports can be obtained from the Forest Regions and Forest Districts.

Different methods have been developed for determining terrain hazard ratings (see Section 2.32). One method that uses soil maps or soils and landforms maps is Boydell and Walmsley (1975).

A method for determining geological hazards from terrain maps is outlined in the working report Guide to the preparation of a geological hazards map (Ryder 1980). This method is intended for persons without geological or geotechnical training and for planning purposes at the management unit level.

SOURCES OF INFORMATION

A basic understanding of soil and landform characteristics is required to identify highly sensitive soils. Also, knowledge of various harvesting techniques and their potential impact on soil and terrain is important. The identification of ES sites should be done in consultation with the following agencies and references:

A. Ministry of Forests

1. Regional and district staff.
2. Pedologists, engineers, ecologists, silviculturalists and people having local knowledge of the area.
3. Ecological classification system for the Forest Region.


B. Ministry of Environment

1. Specialists in soils and in terrain analysis.

2. Soil, soils and landforms, and terrain maps - these maps are available for much of the province from the map library, Maps B.C. (387-1441) and can be used to determine slope failure and surface erosion hazards.


C. Ministry of Environment and Ministry of Forests


2.32 cont.

D. Other


E. Air photos

F. Appendices 2-1 and 2-2
2.4 Ep - FOREST REGENERATION

Object

The Ep category identifies areas having actual or potential severe regeneration problems irrespective of the species composition and the age of existing forest cover. All forest sites that are extremely difficult to regenerate and sites having extended regeneration delays that would lead to unacceptable crop rotations are considered for Ep designation.

E.S.A. Classes

The two E.S.A. classes for forest regeneration are high and moderate:

A. High (Ep1)

Apply this E.S.A. class to areas where geoclimatic conditions cause severe forest regeneration problems making them unavailable for sustained timber harvesting.

B. Moderate (Ep2)

Apply this E.S.A. class to areas where brush, wildlife or cattle cause severe forest regeneration problems. Sustained harvesting of these areas is subject to the application of special management of these biotic factors.

2.41 PROCEDURE

The establishment and performance of forest regeneration is dependent on many interrelated geoclimatic and biotic factors. Also, harvesting, site treatment and reforestation procedures are important determinants of forest establishment. However, only areas having severe regeneration problems regardless of harvesting methods or silvicultural treatment are designated as Ep areas.

The geoclimatic and biotic factors affecting site conditions for forest regeneration are discussed under soil and underlying bedrock, landform, elevation and geographic location, aspect, and under brush, wildlife and domestic cattle.

2.411 Geoclimatic Factors

A. Soil and underlying bedrock

The availability of moisture and nutrients and the amount of frost heaving are critical to forest regeneration, and are largely dependent on the type of soil and underlying bedrock.
2.411 cont.

**Moisture Deficiency**

Soil moisture deficits are sometimes caused by porous bedrock, such as sandstone, and by inclined bedding planes. With porous bedrock, subsurface seepage waters may be entirely absent. Moisture deficits caused by porous bedrock is accentuated by a southerly aspect and by extreme coarseness of surficial material.

**Nutrient Deficiency and Depletion**

Certain soils such as those in serpentine outcroppings are low in important nutrients and high in elements toxic to organisms. If possible, rely on local knowledge to identify these areas.

Also, consider high elevation folisols, sandy soils and coarse, well-drained river terrace soils of glaciofluvial origin. Harvesting on such sites may result in nutrient depletion. Similarly, an intensive burn, particularly in mountainous terrain or over thin soils, where all the organic matter is consumed, could result in severe nutrient volatilization, especially of nitrogen, which is confined to a very thin layer.

For details on determining the moisture-nutrient status of an area, see Section 2.412.

**Frost Heaving**

Throughout British Columbia, frost heaving occurs in fine-grained soils wherever the vertical distance between the water table and the frost line is smaller than the height of capillary rise of the soil. Frost heaving shears seedling rootlets and uplifts container seedlings. Soils subject to severe frost heaving are fine silts, silty loams, fine sand-silty mixtures, and soils having a high clay content where the water table is within 50 centimetres of the surface. Employ local knowledge to identify areas subject to severe frost heaving.

**B. Landform**

Consider these landforms for EP delineation:

**Ridges, Knolls and Eskers**

In many areas ridges, knolls and eskers have very dry, thin soils. They commonly have little or no seepage water, and have a high rate of surface evaporation because they are exposed to the wind.

Besides increasing surface evaporation, wind transports snow which can have these side effects:
2. A wind-blown ridge that is bare or has a very thin unprotective snow cover is subject to deep penetration by ground frost.

2. Snow deposition on ridges is minimal and a moisture deficiency usually exists.

3. Seedlings on leeward slopes deeply covered with snow annually for a long time are prone to snowblight (a parasitic fungus).

Exposed Bluffs, Headlands and Islands

Prevailing onshore winds alone may not cause a regeneration delay on exposed bluffs, headlands and islands. However, when combined with shallow soil, rockiness, windblast, desiccation, salt spray and limited seed source, the wind can be critical and these landforms should be considered for Ep delineation.

Talus Slopes and Loose, Colluvial Material

Once logged or burned, talus slopes and areas with loose, colluvial material may become non-productive for a period of 50 years or more. Sometimes, recovery and re-establishment of forest growth may not be possible. These areas also qualify under the Es category.

Lowland Swampy Areas or Moist Depressions

Removal of forest cover reduces evapotranspiration. A reduction in evapotranspiration on very wet areas, if not offset by increased exposure, could lead to saturation of the soil and compound the regeneration problem.

Sand Dunes

Any protective vegetation on sand dunes should not be disturbed because its re-establishment is often impossible.

Floodplain

After disturbance of forest stands on river-flats subject to violent, annual or periodic flooding, forest regeneration is often delayed for a long time with the early seral stage of succession being brush. Before assigning an Ep designation, consider the possibility of regenerating these areas by planting tree species suited for these sites (Sitka spruce, western red cedar, or hardwoods).
C. Elevation and geographic location

Elevation and geographic location influence climate: the more severe the climate the greater the impact on forest regeneration.

The length of the growing season (frost-free period) largely determines the establishment, success and rate of growth of new forests. At high elevations, a short growing season may not allow seedlings to develop root systems sufficient to withstand extremes of drought and temperature. Also, ultra-violet radiation at high elevations may reduce regeneration success. Snow cover, which varies with geographic location and increases with altitude, can reflect enough sunlight to increase greatly the intensity of radiation on adjacent slopes. In addition, freeze-thaw cycles are more prevalent at high elevations than at low elevations, especially during the growing season.

Areas with a high probability for excessive regeneration delay at high elevations include:

1. Open-stockcd or clumpy semi-alpine sites
2. Recent burns at high elevations
3. Steep, high elevation sites that are subject to snow creep and to snow avalanche activity after harvesting. These sites may also qualify under the Ea category.

D. Aspect

Aspect greatly influences soil surface temperature and soil moisture both of which are determinants in the regeneration of forest sites.

In sun-exposed habitats, soil surface temperatures can reach lethal levels during the growing season. For example, surface temperatures can exceed 65 degrees centigrade on southern aspects, while seedlings may start to die-off at surface temperatures as low as 50 degrees centigrade. The effects of surface temperatures are modified by moisture content and the thermal conductivity of surface layers.

Aspect greatly affects soil moisture, which decreases with increases in wind velocity and surface temperature. Wind velocity and direction also largely determine snow accumulation and distribution.

The influence of aspect on soil surface temperatures and on soil moisture content varies markedly with latitude, regional climate, altitude and slope angle.

Generally, critical exposures are south, southwest and west, especially in the dry southern interior. On these slopes, solar radiation and rapid snowmelt contribute to drought and low
productivity. This leads to sparse ground vegetation, which in turn can cause a faster run-off of summer rains.

In northern British Columbia (57° N +), critical aspects are often north to east because snow melt is slow and surface temperatures can be intensely cold making regeneration very difficult.

2.412 Use of Edatopic Grids

An analysis of the moisture-nutrient status of the soil may help to determine if an area, suspected of having severe forest regeneration problems, warrants an Ep designation. All combinations of soil moisture and nutrients from very dry, low nutrients to wet, high nutrients can be shown schematically on an edatopic grid (see Appendix 2-3).

The soil moisture regime refers to the moisture available to vegetation during the growing season. Soil moisture is correlated with soil drainage, depth of organic material, soil texture, soil depth, climate, aspect, slope position, slope gradient, and the presence or absence of an impermeable layer.

The soil nutrient regime refers to the availability of nutrients that are essential for tree growth. Available nutrients are related to soil parent materials, organic layers, physical and chemical weathering, soil pH, cation (nutrient) exchange capacity and the proportion of exchangeable cations which are bases (base saturation).

To estimate the edatopic grid position, use this soil and topographic information: aspect, elevation, slope gradient, slope position, thickness of organic layers, soil depth, soil texture, coarse fragment content, bedrock type.

Then, verify the edatopic grid position using the ecological classification system through which vegetation types having similar soil moisture and nutrient requirements are classified into ecosystem associations. A plant species list is available for each ecosystem association within a biogeoclimatic subzone and each association is named by one or two plant species that are diagnostic.

For each biogeoclimatic subzone, an edatopic grid can be prepared which indicates the moisture-nutrient field or range for each ecosystem association (see Appendix 2-3). Therefore, through the identification of the plants within an area suspected of having forest regeneration problems, determine the ecosystem association. If the edatopic grid position for that ecosystem association concurs with the grid position determined from soil and topographic information, then the soil moisture-nutrient regime of the area has been assessed correctly.

For more details on ecological classification and on edatopic grids, refer to Ecological classification for the Nelson Forest Region (Ministry of Forests, 1982).
2.413 Biotic Factors

Brush, wildlife and domestic cattle can cause severe forest regeneration problems. Because the effect of these factors on regeneration is difficult to assess through photo interpretation, on-site inspection is required in conjunction with regional or district silvicultural staff.

A. Brush

Although brush is often a significant barrier to forest regeneration, not all brush areas require an Ep designation.

1. Forested areas with dense brush understorey

Brush can be very dense under the forest canopy, especially under open forest types (6 to 30 percent crown closure). This brush can seriously interfere with forest regeneration, particularly on areas having little or no advanced regeneration. Examine these areas in conjunction with silvicultural staff and assign an Ep designation when justified.

2. Non-commercial brush (NCBr)

Non-commercial brush (NCBr) is potentially productive forest land occupied by non-commercial brush having a minimum height of one to two metres and a crown closure of 60 percent or greater (see Chapter 3).

On sites that are correctly classified as NCBr, a productive forest type could be established and supported if the brush was removed. However, because the NCBr classification label adequately describes the site, do not assign an Ep designation to NCBr areas.

3. Non-productive brush (NPBr)

Non-productive brush (NPBr) is an ecologically stable community of brush species, usually willow or slide alder, on land that has little or no potential for conversion to productive forest. NPBr includes sites with permanently high water tables, snow chutes and high elevation sites with snow cover of long duration (see Chapter 3). Do not assign an Ep designation to NPBr areas.

B. Wildlife

Large populations of ungulates, as evidenced by overbrowsed brush or a well defined browse-line, can seriously damage the growth of young trees. Examples are winter ranges, where snow limits the availability of forage so that seedlings projecting above the snow may be browsed until they are killed. Only assign an Ep designation to areas affected by wildlife if the regeneration problem is extreme and upon recommendation of silvicultural staff.
B. Domestic cattle

Heavy grazing or trampling by domestic cattle may cause a normally productive area to become static or to deteriorate. Examples in semi-arid climates are areas adjacent to subalpine livestock summer ranges and open-grown climax forests of ponderosa pine and Douglas-fir. Again, only assign an Ep designation to areas affected by cattle if the regeneration problem is extreme and upon recommendation of silvicultural staff.

2.414 Classification of Ep Areas: Ep1 or Ep2

Ep areas are selected through air photo interpretation, supported by ground or air examination, in consultation with regional and district silvicultural staff and other sources of local knowledge.

It is suggested that all areas anticipated to have regeneration delays of 20 years or more after a major disturbance, such as harvesting or wildfire, be considered for Ep designation.

Areas for Consideration as Ep1

Areas are designated as Ep1 where geoclimatic factors cause severe actual or potential forest regeneration problems making them unavailable for sustained timber production. Remember that the effect of geoclimatic factors on regeneration varies locally.

Consider these areas for designation as Ep1:

A. Sites with soil or underlying bedrock types that create moisture or nutrient deficiencies:
   - Porous bedrock
   - Highly alkaline soils
   - High elevation folisols
   - Sandy and other coarse, well-drained soils

B. Soils subject to severe frost heaving especially where the water table is within 50 centimetres of the surface:
   - Fine silts
   - Silty loams
   - Fine sand-silty mixtures
   - Soils having a high clay content

C. Landforms commonly having regeneration problems:
   - Knolls, ridges and some sites having coarse outwash material
   - Exposed coastal bluffs, headlands and islands
   - Talus slopes and areas with loose, colluvial material
   - Areas with high water tables such as outer coastal lowlands and swampy areas
   - Sand dunes
   - River-flats subject to violent, periodic flooding
- Steep, high elevation sites prone to excessive snow movement
- In heavy snowfall areas, sites adjacent to subalpine brush areas and sites below rock exposures that are susceptible to snow creep if harvested

D. High elevation sites
- Open-stocked or clumpy subalpine forest with little advanced regeneration (occurs at lower elevations in some areas)
- Recently burned areas adjacent to the alpine forest zone

E. Critical aspects
- South, southwest and west exposures in the dry, southern interior of British Columbia
- North to east aspects in northern British Columbia (57°N +)

Areas for Consideration as EP2

Areas are designated as EP2 where biotic factors (brush, wildlife and domestic cattle) cause severe forest regeneration problems. Timber harvesting is conditional to special management.

Consider these areas for designation as EP2:

A. Brush
Forested areas with dense brush understorey.

B. Wildlife
Ungulate winter ranges where seedlings are seriously overbrowsed.

C. Domestic cattle
Areas that are static or deteriorating because of heavy grazing or trampling such as open-grown climax forests of ponderosa pine and Douglas-fir that border open range in semi-arid climates.

2.42 SOURCES OF INFORMATION

A. Ministry of Forests

1. Silviculture Branch
2. Research Branch
3. Regional and district silvicultural staff
4. Ecological classification system for the Forest Region
5. Range Management Branch
2.42 cont.

B. Ministry of Environment

1. Specialists in soils and in terrain analysis.
2. Soil, soils and landforms, and terrain maps - these maps are available for much of the province from the ministry map library (387-6995).

C. Ministry of Environment and Ministry of Forests


D. Canadian Forestry Service
Pacific Forest Research Centre
506 Burnside Road West
Victoria, B.C.
V8Z 1M5
2.5  

**Ea - SNOW AVALANCHE**

**Object**

The Ea category is intended to protect man-made structures and valuable natural resources from snow avalanches.

**E.S.A. Class**

The E.S.A. class for snow avalanche is high.

2.5.1  

**PROCEDURE**

The mountainous terrain of British Columbia has many avalanche zones. Snow avalanches can destroy man-made structures, natural resources, and transportation and communication links.

The threat of most snow avalanches is confined to well defined avalanche tracks or chutes. However, the removal of forest cover from steep slopes in snow belts having high accumulation can create potentially destructive snow movement zones. While it is difficult to control the effects of large avalanches, it is possible to reduce the frequency and effects of small ones by the application of snow avalanche E.S.A.s. The application of these areas should only be considered where they can effectively protect values important to society.

2.5.1.1  

**Values to be Protected**

Snow avalanche E.S.A.s may make commercial timber unavailable for harvesting for a long time. Therefore, ensure that the values in question warrant protection. Some values to be considered are:

A. Industrial developments, and urban and rural settlements

B. Main highways and secondary roads

C. Railways

D. Well used recreational sites

E. Powerline towers

F. Forest land of medium to high site

G. Sites that are subject to potentially lengthy regeneration delays from snow avalanches or from snow creep after harvesting. Alternatively these sites may qualify under the Ep category.
2.512 Assessment of Avalanche Hazard

The frequency and magnitude of snow avalanches are difficult to predict. However, predictions can be made using several factors, which can be interpreted from aerial photographs or extrapolated from climatic records. These factors are:

A. Climatic data including snow depth, frequency and magnitude of snow falls, and direction of prevailing winds
B. Slope angle of the starting zone
C. Profile characteristics of the avalanche track
D. Evidence of avalanche activity
E. Characteristics of forest and non-forest cover within and adjacent to the snow track

Approximated hazard ratings for various avalanche prediction factors are listed in Table 2-3. Use these ratings as a guide only.

2.513 Classification of Ea Areas

Where a snow avalanche E.S.A. (Ea) is justified (see Section 2.511), effective boundaries to it must be determined.

An avalanche path has three parts: starting zone, track, and runout zone (see Figure 2-1). Some avalanche paths have an airblast zone below the runout zone. Designate snow avalanche protection areas in forest types at the starting zone or the runout zone.

Figure 2-1 Avalanche path: starting zone, track, and runout zone
<table>
<thead>
<tr>
<th>Part of Avalanche</th>
<th>Hazard Factors</th>
<th>High</th>
<th>Hazard Ratings</th>
<th>Medium</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Starting Zone</strong></td>
<td>Annual snow depth</td>
<td>2 m +</td>
<td>0.5-2 m</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Single snowfall</td>
<td>0.5 m +</td>
<td>0.25-0.5 m</td>
<td>0.25 m</td>
<td></td>
</tr>
<tr>
<td><strong>Slope angle:</strong></td>
<td>Interior Coast</td>
<td>30° to 45°</td>
<td>25°-30°,45°-55°</td>
<td>25° and 55°</td>
<td></td>
</tr>
<tr>
<td><strong>Configuration</strong></td>
<td>Bowls, lee slopes, (high snow accumulation)</td>
<td></td>
<td></td>
<td>Wind-swept slopes (low snow accumulation)</td>
<td></td>
</tr>
<tr>
<td><strong>Roughness</strong></td>
<td>Smooth</td>
<td></td>
<td></td>
<td>Rough, rocky</td>
<td></td>
</tr>
<tr>
<td><strong>Forest cover</strong></td>
<td>None</td>
<td></td>
<td>Scattered forest</td>
<td>Extensive cover 10 m +</td>
<td>high forest cover</td>
</tr>
<tr>
<td><strong>Areas of</strong></td>
<td>accumulation</td>
<td>2 ha</td>
<td>1 to 2 ha</td>
<td>1 ha</td>
<td></td>
</tr>
<tr>
<td><strong>Snowtrack</strong></td>
<td>Slope</td>
<td>Continuously steep, with or without cliffs</td>
<td></td>
<td>25° to 35° for most of length</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cross sectional profile</td>
<td>Steep-sided, narrow</td>
<td></td>
<td>Flat, wide open</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Top view</td>
<td>Straight, few bends, uniform slope</td>
<td></td>
<td>Winding with bends or stops</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Forest cover</td>
<td>None: grass, willow, alder</td>
<td>Patchy forest cover 10 m + high</td>
<td>Good cover 10 m + high</td>
<td></td>
</tr>
<tr>
<td></td>
<td>History</td>
<td>Recent extensions or broadening of snowtracks within last 40 to 50 years</td>
<td></td>
<td>No signs of snowtrack expansion</td>
<td></td>
</tr>
</tbody>
</table>
Starting Zone

Snow accumulates at the starting zone, which is the critical area for snow avalanches. The areas adjacent to the starting zone, especially on the windward side, are also critical.

Therefore, consider all high elevation forest within or adjacent to the starting zone for delineation as Ea areas (see Figure 2-2).

![Diagram of starting zone with text annotations](image)

**Figure 2-2** Protection buffer in avalanche starting zone

Runout Zone or End Zone

A protective buffer in the runout zone is usually effective in controlling small, slow avalanches only. Little can be done to stop the damage caused by large, fast avalanches.

The size and shape of the buffer zone depend upon the topography, the resistance of the residual forest cover to wind, and the configuration of the runout zone. Some applications of the Ea category are shown in Figures 2-3 and 2-4.
Figure 2-3  Runout zone - no protection required

Figure 2-4  Forests used as avalanche buffers
2.5133 Other Applications

A. Sites where snow movement may cause severe forest regeneration problems after removal of the forest cover:

1. Areas having certain combinations of steepness, elevation, snowfall, aspect, local terrain, and weather conditions. Removal of forest cover from these areas can cause snow avalanches which can seriously delay reforestation.

2. Sites adjacent to subalpine brush areas having heavy snowfall where the removal of forest cover tends to predispose the site to snow creep and to further downslope encroachment by brush.

3. Timbered slopes below rock exposures that are susceptible to snow creep.

Note 1: These areas may also qualify under the Ep category.

B. Immature stands in active avalanche tracks

Stands or patches of immature trees often grow in active avalanche tracks, only to be destroyed by periodic avalanches. Where there is evidence of this occurring, designate these stands of immature forest as Ea areas because harvesting of them is unlikely to occur.

2.52 SOURCES OF INFORMATION


B. G.L. Freer
   Head Snow Avalanche Section
   Ministry of Transportation and Highways
   Highways Operational Services Division (Victoria)
   Tel: 387-1738

C. P. Schaerer
   National Research Council of Canada
   3904 West 4th Avenue, Vancouver, B.C., V6R 1P5
   Tel: 732-4829

D. Ministry of Environment
   Water Management Branch
   Surface Water Section (Victoria)
   Tel: 387-1111

E. Appendix 2-2, 2-4.
2.6 **Er - RECREATION**

**Object**

The Er category identifies areas having significant value for recreational activity or viewing enjoyment.

**E.S.A. Classes**

The two E.S.A. classes for recreation are high and moderate:

A. High (Er1)

Apply this E.S.A. class to areas having exceptionally high value for recreation or viewing, where harvesting is likely to be severely limited.

B. Moderate (Er2)

Apply this E.S.A. class to areas having high value for recreation or viewing but less than that for Er1. Forest harvesting is conditional in Er2 areas.

2.61 **PROCEDURE**

The forest recreational resource can be subdivided into two broad categories: recreational features and landscape (visual) features.

To designate Er areas, identify all areas in the unit that have recreational potential and those that are visually important by referring to the Ministry region/district recreational inventory and planning maps, to Canada Land Inventory (C.L.I.) recreational capability maps, and by relying on local knowledge and photo interpretation. Identify areas having value for recreational activity and viewing.

2.6.11 **Recreational Features**

A recreational feature is a physical, biological, cultural or historic aspect of an area making it attractive for actual or potential recreational use.

A. Locations with physical, biological, cultural or historic features that have significant value for recreation

When reviewing the physical, biological, cultural and historic features in management units, examples of many of the features listed in this section will likely be found. Normally, only those features of exceptional quality, uniqueness and availability having recreational, educational, scientific or heritage value are considered for Er designation.

The features listed do not automatically require an Er designation but need to be evaluated for significance on an individual basis.
2.611 cont.

1. Physical and biological features

   a) Aquatic flora and/or fauna - those that have significant value.

   b) Beaches - significance depends upon texture, gradient, width, length, offshore conditions, backshore conditions, occurrence of inundation, and stability.

   c) Hydrologic - non-biotic features including waves, tides, currents, unique water colour and junctions of major rivers.

   d) Vegetation - unique flora not found elsewhere in the unit or Forest Region.

   e) Waterfalls, rapids and chutes.

   f) Glaciers, glacial features, icefields and snowfields.

   g) Coastal features - estuaries, tidal marshes, lagoons, tidal flats, rock platforms and ledges, spits, hooks, points and tombolos.

   h) Landform features - pronounced landforms that have developed as a result of various erosional and depositional processes. Includes glacial landforms, karst, talus slopes, landslides, canyons, hoodoos, and caves.

   i) Small surface waters - tarns, ponds, sloughs, small lakes and small streams.

   j) Topographic features - distinct and diverse elements of the landscape that provide recreational interest or provide opportunity for a wide range of dispersed activities (hiking, riding, camping, exploration, photography) in an attractive setting; examples of which include some high elevation areas and shorelines of lakes, large rivers and the ocean.

   k) Rock formations - exposed bedrock, knolls, ridges, escarpments, cliffs, exposed internal rock structure, mineral deposits, fossils and volcanic features.

   l) Springs - thermal, freshwater and mineral.

   m) Trails - significance depends upon use and purpose.

   n) Harbour - protected bays or water with potential for boat moorage, launching or other harbour-marine activities.
2.612

Wildlife - areas which provide a unique opportunity to view concentrations or significant populations of land mammals, birds, reptiles and amphibians.

2. Cultural and historic features

a) Cultural features - modern or present day.

b) Native Indian sites - archaeologic sites (middens, old villages, artifacts, totem poles), pictograph and petroglyph sites, and legend sites.

c) European/pioneer sites - areas related to early European exploration and pioneer history.

Note: For more details on the physical, biological, cultural and historic features and sub-features, refer to the Ministry of Forests Recreation Manual, Appendix IX 'Recreation Resource Inventory' section 5.

B. Locations where current use is concentrated

1. Forest Service recreational sites and trails - locations developed to facilitate public use of the forest.

2. Unorganized picnic areas and camping spots.

2.612

Landscape (Visual) Features

A landscape feature is a distinct or outstanding part, quality or characteristic of a landscape.

A. Areas to be considered for Er designation

1. Areas immediately adjacent to or surrounding public-use areas and specific recreational features.

2. Sections of:

   a) Land/water interface - usually these areas are extensively used because they offer varying and contrasting scenery.

   b) Travel routes or corridors - margins of main highways, recreational access roads, trails, lakes, rivers and coastal waters.

3. Aesthetically pleasing areas visible from communities.
B. Visible areas not to be considered for Er designation

Normally, middleground and background areas should not be given an Er designation. In steep terrain, middleground and background areas can be extensive and should not be designated Er because the intent of this category is to protect site-specific recreational and landscape features that are highly sensitive to disturbance. In flat terrain, the middleground and background are even less visible and sensitive to disturbance.

At times, a portion of the middleground or background is an important part of the view from a public site or a viewpoint making it sensitive to disturbance. Designate these areas as Er.

2.613 Classification of Er Areas: Er₁ or Er₂

With regional and district guidance, classify these recreational and landscape features by their significance for recreation and their sensitivity to environmental modification, particularly harvesting. Significance for recreation is determined by the quality, uniqueness and availability of a feature. Sensitivity to modification might be nil, moderate, or great. Having assessed the sensitivity of the area, assign the required E.S.A. class (Er₁ or Er₂), if warranted. Use the Er₁ designation mainly for small areas where harvesting will not normally be permitted.

When defining Er areas, ignore ownership and land status. Er boundaries should follow topographic features, other E.S.A. boundaries, or forest type lines rather than the boundaries of parks and other reserves.

Areas for Consideration as Er₁

- Forest Service recreational sites and trails
- Unorganized picnic areas and camping spots having high current use
- Small islands

Normally, assign Er₁ to small islands having high current recreational use or significant physical, biological, cultural or historic features. For larger islands, or portions thereof, apply Er₁ or Er₂ according to an assessment of size, location, and use, if warranted

- Archaeological sites
- Historic sites
- Rare or unique features (follow regional guidelines)
Areas for Consideration as $E_{r_2}$

- Aquatic flora and/or fauna
- Beaches
- Hydrologic features
- Vegetation
- Waterfalls
- Glaciers
- Coastal features
- Landform features
- Small surface waters
- Topographic features
- Rock formations
- Springs
- Trails
- Harbour features
- Wildlife viewing areas
- Landscape features

2.62 SOURCES OF INFORMATION

A. Ministry of Forests

2. Forest Region
   - Recreation Officer and staff
3. Forest District
   - Recreation and Timber Resource Officers
   The Forest Regions and Districts have recreational inventory and planning maps that indicate local recreational and landscape values. Often, detailed information on 'feature significance' and 'management class' is readily available.

B. Ministry of Environment

1. C.L.I. recreational capability maps
2. Outdoor recreational features mapping

C. Ministry of Lands, Parks and Housing, Parks and Outdoor Recreation Division, Victoria and regional staff

D. Heritage Advisory Board (Victoria)

E. Ministry of the Provincial Secretary and Government Services, Heritage Conservation Branch

F. Outdoor Recreation Council of British Columbia (Vancouver)

G. Local interest groups
2.7 **Ew - WILDLIFE**

**Object**

The Ew category identifies areas having significant value for food, shelter, or reproduction for wildlife.

**E.S.A. Classes**

The two E.S.A. classes for wildlife are high and moderate:

A. **High (Ew1)**

Apply this E.S.A. class to areas of critical importance to wildlife where the removal of any timber would be detrimental. This class is to identify extremely important areas which provide basic food, shelter and/or sites for reproduction for wildlife.

B. **Moderate (Ew2)**

Apply this E.S.A. class to site specific areas having high value for wildlife but less than that for Ew1. An Ew2 designation is used when a significant portion of the timber within an area is important to wildlife and the harvesting of it is conditional.

**PROCEDURE**

For survival and optimal development, each wildlife species requires balanced environmental conditions such as topography, climate, shelter, and vegetation. A change in the environment can lead to a number of animal responses; for example, one animal species may flourish whereas the survival of another might be threatened. Therefore, it is important not only to know both the critical habitats for wildlife but also their responses to different methods of timber harvesting and to other management practices.

Information on species occurrences, habitat requirements, and land capabilities for wildlife is available from the regional Wildlife Branch offices and from other agencies.

Identification of E.S.A.s for wildlife through on-site examination (ground or air) and air photo interpretation should be done in conjunction with the biologists and technicians of the Wildlife Branch, whenever possible.

The Ew category may be used to identify extremely important areas for any species of wildlife but it is predominantly used to identify these areas for big game species (including grizzly bear, caribou, deer, elk, goat, moose, sheep), for birds (certain waterfowl and raptors), and for any endangered or threatened species of wildlife.
An endangered species is a species of wildlife that is threatened with imminent extinction throughout all or a significant portion of its range in the province owing to the action of man (Wildlife Act, 1982). At present, these species are designated as endangered species by the Lieutenant Governor in Council: white pelican, burrowing owl, sea otter, and Vancouver Island marmot.

A threatened species is a species of wildlife that is likely to become endangered in the province if the factors affecting its vulnerability are not reversed (Wildlife Act, 1982). At present, no species are officially designated as threatened species.

2.711 General Habitat Characteristics for Various Big Game Species

Habitat requirements for each wildlife species can vary considerably: for example, caribou in northern British Columbia versus caribou in southern British Columbia, moose in high snowfall areas versus moose in low snowfall areas, and grizzly bear with access to salmon runs versus grizzly bear without access to salmon runs.

Here, we list some very general habitat characteristics for various big game species in British Columbia. To determine the local habitat needs for big game and for any bird or mammal species, consult the regional Wildlife staff and Wildlife Habitat Handbooks for British Columbia (Ministry of Environment).

A. Grizzly bear

1. The spring range of grizzly bears is often avalanche and swamp complexes. Timber is required for cover along avalanche tracks.

2. In the summer they move to berry patches and to marmot colonies.

3. In the autumn, grizzlies with access to salmon runs, congregate along salmon-spawning reaches of streams but afterwards they move into the alpine.

B. Caribou

1. Caribou usually prefer the alpine and subalpine but they can be driven by snow into forest land.

2. They prefer less steep forested areas.

3. Often they travel over frozen lakes and through sedge meadows in winter. An Ew strip along the shoreline of these lakes and meadows may be required.

4. When in timber, they feed on arboreal lichens, which are found in over-mature forests with 50- to 80-percent crown closure.
C. Mule deer

1. Mule deer prefer open, coniferous forest and sub-climax brush on steep and broken terrain.

2. Their winter range is:
   a) Semi-open forest in low snow areas.
   b) Closed-canopy coniferous forest with lichen and litter fall available for food in deep snow areas.

3. Their spring range is on:
   a) Open sidenills having southern aspects.
   b) Rock bluffs.

D. White-tailed deer

1. White-tailed deer prefer an interspersion of forest cover and range types such as that found at the edges of hardwood forests, swamp areas and meadows.

2. They need some coniferous stands for shelter.

3. They browse primarily deciduous shrubs and saplings.

4. In spring they are on the "greened-up" south facing slopes.

E. Rocky mountain elk

1. Rocky mountain elk prefer open areas, aspen types and parkland.

2. They need some coniferous timber for shelter when deep snow lies on the ground, for escape cover and for calving grounds.

3. They are primarily grazers, pawing through light snow to reach grasses in winter. This grazing is supplemented by some deciduous browsing.

F. Roosevelt elk

1. Roosevelt elk need coniferous forest with scattered small openings.

2. They winter exclusively in the valley bottoms.

3. For consumption they utilize browse, grasses and forbs.
G. Mountain goat

1. Mountain goats prefer steep, grassy slopes, talus, ravines and cliffs.
2. They require fingers of timber along ravines for vertical migration and cover, especially on the coast.
3. They derive minor food sources from mature forests.

H. Moose

1. Moose winter in valley bottoms but seasonally may migrate up and down mountain slopes.
2. They require coniferous cover in close proximity to winter range for protection, especially in heavy snowbelts.
3. They are primarily browsers.
4. Their winter range generally consists of deciduous forest in areas having low accumulations of snow and willow-swamp complexes.

I. Bighorn sheep

1. Bighorn sheep require steep, rugged cliffs, adjacent to winter ranges, for lambing sites.
2. Their winter range is on grassy slopes at low elevations with south to southwest aspects.

J. Thinhorn sheep

1. Thinhorn sheep are found mainly in the alpine in northern British Columbia.
2. They winter on grassy slopes at low elevations.

2.712 Classification of Ew Areas: Ew1 or Ew2

A. Identify the recognized wildlife species in the area that may be adversely affected by forest harvesting.

B. Identify important habitat requirements for each wildlife species. Some requirements to consider are preferences for forest cover, ground cover, elevation, slope, aspect, and landform (see Section 2.711, and consult the Wildlife Branch).
2.712 cont.

C. For each species needing protection, map the areas having high capabilities and/or species occurrences as indicated by the Canada Land Inventory (C.L.I.) land capability maps for ungulates and for waterfowl and by regional sources of information.

D. Identify and indicate on composite forest cover maps of 1:50 000 scale those sites providing the identified habitat requirements that are located within areas of high wildlife capability. To identify these important habitats on a site-specific basis, use photo interpretation as an aid.

E. On the ground or from the air, check the validity and extent of as many of these proposed Ew areas as possible.

Areas for Consideration as Ew1

Areas designated as Ew1 should be based on site-specific, quantifiable and supportable information provided by the Wildlife Branch or by other qualified agencies.

Consider these areas for designation as an Ew1:

A. Stands that provide periodic but essential shelter from adverse conditions (thermal cover).

B. Mature or overmature forested areas that supply lichens and other blowdown food necessary for the survival of species such as mountain caribou and black-tailed deer during the winter in areas having high accumulations of snow.

C. Areas vital to the preservation of endangered, threatened or rare species (for example, peregrine falcon nesting sites).

D. Reproductive sites, mineral licks, migration corridors, and bird colonies.

Areas for Consideration as Ew2

Areas designated as Ew2 must have high value for food, shelter or reproduction, and the removal of timber from them is conditional. These wildlife habitats may not be critical for species survival but a good portion of the forest cover is required for the well-being of the species. An example is a mature forest used by moose for winter shelter where timber extraction would be acceptable provided a certain amount of cover is left after logging.
2.713 Mapping and Labelling

A. Ew boundaries should follow forest type boundaries and other E.S.A. boundaries wherever possible.

B. Wildlife species labels

Wildlife species are identified in the Ew label by alphabetic lower case subscripts (see Table 2-4) and are listed in order of importance.

The individual species for birds and for endangered or threatened species will not be indicated in the Ew label but should be indicated in the accompanying E.S.A. report (see Section 2.12.)

Table 2-4
Symbols for wildlife species

<table>
<thead>
<tr>
<th>Wildlife Species</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grizzly bear*</td>
<td>b</td>
</tr>
<tr>
<td>Caribou</td>
<td>c</td>
</tr>
<tr>
<td>Deer</td>
<td>d</td>
</tr>
<tr>
<td>Elk</td>
<td>e</td>
</tr>
<tr>
<td>Goat</td>
<td>g</td>
</tr>
<tr>
<td>Moose</td>
<td>m</td>
</tr>
<tr>
<td>Birds</td>
<td>o</td>
</tr>
<tr>
<td>Sheep</td>
<td>s</td>
</tr>
<tr>
<td>Endangered or threatened species</td>
<td>t</td>
</tr>
</tbody>
</table>

* To indicate important grizzly bear habitat along salmon streams see Figure 2-5

Examples: Ew2ed Elk and deer Ew1m Moose
C. Grizzly bear

Important habitats for grizzly bears along salmon producing streams are designated as EW2 and indicated as illustrated in Figure 2-5.

![Figure 2-5 Grizzly bear symbols along salmon streams](image)

### 2.72 SOURCES OF INFORMATION

A. Ministry of Forests
   Regional and district staff

B. Ministry of Environment
   1. Wildlife Branch
      - Headquarters and regional staff
      - Wildlife Habitat Handbooks for British Columbia
   2. Surveys and Resource Mapping Branch
      C.L.I. capability maps for ungulates and for waterfowl

C. Canadian Wildlife Service
   5421 Robertson St.
   Delta, B.C.
   Tel: 946-8546

D. Provincial Museum
   1. Curator of vertebrate zoology
   2. Natural History Handbooks

E. Licensed outfitters and guides
2.8  **En - WATER**

**Object**

The En category identifies watersheds or portions thereof that require protection or special management to maintain water quality, quantity and seasonal distribution for consumptive use (domestic, agricultural and industrial).

**E.S.A. Classes**

The two E.S.A. classes for the protection of the surface water resource for consumptive use are high and moderate:

**A. High (En₁)**

Apply this E.S.A. class to localized areas having very high water values and where sensitivity to timber harvesting is extreme because it would have a serious, long-term, adverse effect on water quality, quantity and/or seasonal distribution.

**B. Moderate (En₂)**

Apply this E.S.A. class to areas having very high water values that are sensitive to timber harvesting but less sensitive than those designated as En₁. Harvesting in En₂ areas is subject to special management considerations.

2.81 **PROCEDURE**

British Columbia has an ample supply of surface water for consumptive use provided that the watersheds are managed to maintain the quality, quantity, and seasonal distribution of this water at current or improved standards. For details on the objectives for watershed management see Appendix 2-5.

A watershed is defined as the total area of natural upstream drainage above any point of reference on a stream.

2.811 **Water Quality, Quantity and Seasonal Distribution**

**Water quality**

Water quality is extremely important in many watersheds, especially in those used for domestic water supplies. Sedimentation of streams is the most common cause of impairment of water quality. Erosion and consequent sedimentation is dependent on precipitation, soil, landform, topography and vegetation. When occurring at low, natural rates, sedimentation seldom has significant effects on water quality. However, timber harvesting involves the construction of roads, the removal of much of the ground cover, and often the application of prescribed burning, all of which may hasten erosion. Through proper management of these activities, erosion and sedimentation can usually be held to acceptable levels.
Water Quantity and Seasonal Distribution

Forest harvesting can effect the quantity and seasonal distribution of water within a watershed. Generally, harvesting increases the water yield by increasing the amount of rain and snow that reaches the ground and by decreasing the loss of water through evapotranspiration. Also, harvesting may change the amount and timing of peak and low flows. With good planning of harvesting, managers can maintain or improve the annual water yield and the minimum low flows of most watersheds.

Community Watersheds

A community watershed is any natural watershed area on which a community or group of individuals holds a valid water licence issued under the Water Act by the Comptroller of Water Rights.

Community Watershed Guidelines

Guidelines for the use and development of resources within a community watershed are specified in the October, 1980 task force report 'Guidelines for Watershed Management of Crown Lands used as Community Water Supplies' (1980 or any subsequent revision). The guidelines for forestry and for the construction of roads are included in Appendix 2-5).

Community Watershed Classification

For application of the community watershed guidelines, community watersheds are classified according to three categories based on size only.

Note: A few watersheds are reclassified into other categories where the guidelines do not comply owing to existing activities or location. Ultimately, each watershed must be considered on a site-specific basis.

Appendix G of 'Guidelines for Watershed Management of Crown Land used as Community Water Supplies' (1980 or any subsequent revision) lists the community watersheds in British Columbia by category, drainage area, population served, and by land status.

A. Category I community watersheds

Category I generally includes all community watersheds under 6 square miles (15.5 square km) in area and are usually those designated for maximum protection. Some category I watersheds are not compatible with other land use activities, whereas some are.

Forest harvesting in category I watersheds must enhance watershed management goals.
B. Category II community watersheds

Category II includes those watersheds between 6 and 35 square miles (15.5 and 90.6 square km). Other land use activities might be permitted under close scrutiny in accordance with the guidelines.

C. Category III community watersheds

Category III includes those community watersheds between 35 and 200 square miles (90.6 and 518.0 square km) in area. Only very general controls are imposed in these watersheds to maintain the raw water in a condition suitable for conventional forms of treatment (see 'Guidelines for Watershed Management of Crown Land used as Community Water Supplies').

D. Main stem community watersheds

Community watersheds having a drainage area exceeding 200 square miles (518.0 square km) are referred to as main stem watersheds and are not covered in the guidelines. Land users within these large community watersheds are expected only to comply with the restrictions of various Acts (Health Act, Pollution Control Act, Water Act, Municipal Act, Forest Act).

2.813 Other Watersheds with High Water Values

Many licensed and non-licensed streams in British Columbia supply water to individuals for domestic, agricultural or industrial use and are not classified as community watersheds. Although the guidelines were developed primarily for application to community watersheds, it is suggested that they be applied equally to those watersheds supplying individual users.

2.814 Watershed Planning

Each watershed is unique depending on type and amount of water use, size, location, topography, climate, forest cover, soil, ground vegetation, land uses, and other resource values. Therefore, the general guidelines for category I, II and III community watersheds should be refined on an individual basis through watershed management planning at the regional and district levels.

Multi-resource plans should be prepared for each community watershed involving the Ministries of Forests and Environment, other Ministries, local governments (municipal and/or Regional district), licensed water users, forest licensees, other licensed resource users, and the general public, as required.

The watersheds of all licensed and non-licensed streams that have high water values but are not recognized as community watersheds should receive similar multi-resource interdisciplinary planning.
2.815 Classification of Eh Areas: Eh₁ or Eh₂

The classification of Eh areas is to be done in consultation with the Regional and/or District Forest Manager and the Regional Water Manager and is to conform to watershed management plans, when available.

A. Identify watersheds having high water values for consumptive use:


2. Streams having valid water licences but not classed as community watersheds - see Regional Water Manager (stream register).

3. Non-licensed streams - see Regional Water Manager, Forest District Manager, other local sources of information.

B. Define the topographic boundary of each watershed by air photo interpretation.

C. Identify those watersheds that are to be:

1. Managed exclusively for water values where forest harvesting will not normally be permitted.

2. Managed for both water and timber with water having top priority.

D. For watersheds managed for both water and timber determine:

1. Watersheds that require an Eh₂ designation of all forest land within the boundaries. Only use this method for smaller watersheds and upon regional request.

2. Watersheds that require only site-specific Eh₁ and/or Eh₂ designations within the boundaries. Delineate site-specific Eh areas through air photo interpretation and field examination with guidance from hydrologists, pedologists, foresters and engineers. Factors to consider are type of water use, amount of water use, size of watershed, potential for sedimentation, contribution to runoff regime, existing water supply system, and potential for revegetation.

Areas for Consideration as Eh₁

Areas are designated as Eh₁ where forest harvesting is expected to lead to unacceptable sedimentation based on site-specific information.

A. Entire area of those category I watersheds within which forest harvesting will not normally be permitted.
B. Extremely sensitive sites within category I, II, III community watersheds or within watersheds having individual licensed water users.

Areas for Consideration as Eh2

Areas are designated as Eh2 where special harvesting prescriptions and/or constraints are required to prevent unacceptable sedimentation or to maintain or enhance water production or minimum flows.

A. Entire area within selected category I and II community watersheds or within selected watersheds having individual licensed water users.

B. Selected sensitive sites within category I, II, III community watersheds, within watersheds of individual holders of water licences, or within non-licensed watersheds having very high water values.

2.82 SOURCES OF INFORMATION

A. Ministry of Forests

1. Regional and district staff
2. Hydrologists, pedologists, engineers

B. Ministry of Environment

1. Regional Water Manager and staff
2. Water Management Branch
   - Surface Water Section
   - Licensing Section
3. Planning and Assessment Branch
   - strategic plans

C. Watershed management plans

D. Licensed resource users within community watersheds

E. Local governments
   - Municipal
   - Regional district
2.9 FISHERIES

Object

The fisheries category identifies the importance of streams\(^1\), or stream reaches\(^2\), to fish and the sensitivity of streams to disturbance by forest harvesting and other management practices.

Fisheries-value and Stream-sensitivity Rating

The four fisheries-value and stream-sensitivity ratings are: nil, low, moderate, and high.

2.91 PROCEDURE

Streams or stream reaches are classified as a function of the actual or potential value for fisheries and of the sensitivity to disturbance by forest harvesting.

2.911 Stream Value for Fisheries

Streams or stream reaches are evaluated on their potential for migration, rearing, or spawning regardless of current populations or utilization.

For many streams in British Columbia, detailed information on fish populations and potentials is available. For details on salmon streams see the Department of Fisheries and Oceans of the Government of Canada and for details on resident\(^3\) sport fish, steelhead and coastal cutthroat streams, consult the Fisheries Branch. Otherwise evaluate streams through photo interpretation, reliable local sources, or on-site inspection in conjunction with the provincial Fisheries Branch and the federal Department of Fisheries and Oceans, whenever possible.

Classify streams into one of four stream-value-for-fisheries classes: none, low, medium, and high. These classes are based upon no capability for fisheries (none) and upon actual or potential capability for migration (low), for rearing (medium) and for spawning (high):

A. None

A stream reach with a gradient of more than 10 percent.

---

1 A stream is a watercourse that has a flow of water between continuous definable channel boundaries for all or part of the year.
2 A stream reach is a relatively homogeneous section of a stream having a repetitious sequence of physical processes and habitat types.
3 Resident fish are fish that remain in fresh water throughout their life cycle.
B. Low

A stream reach used primarily for migration of fish (usually sea-run species) to or between higher value areas where rearing or spawning occurs.

C. Medium

A stream reach used primarily for rearing of fish. Such reaches are often characterized by the presence of back channels, side channels, a meandering streambed, or by small tributaries with protective cover provided by overhanging vegetation or cutbanks.

D. High

Stream reaches having spawning areas and highly productive rearing areas. For example, the inlets and outlets of lakes are likely spawning areas. Important factors that determine spawning value are gravel size, degree of compaction and sedimentation, and rates of flow at certain times of the year. These factors are difficult to identify without extensive on-site inspection.

2.9.12 Stream Sensitivity to Disturbance

The sensitivity of a stream to disturbance by forest harvesting is a function of:

A. Amount of forest cover in the watershed

B. Water volume

A large, deep and/or wide stream is less sensitive to disturbance than is a small, shallow one.

C. Streamside soil stability or erodability

To determine streamside soil stability, see Section 2.3.

D. Stream flow regime

A large watershed exhibits a less "flashy" flow pattern than does a small one. Also, a lake-headed system is usually more stable than is a non-lake-headed one. Any fluctuation in flow pattern is usually amplified after harvesting.

E. Terrain

Sensitivity to disturbance is greater on steep, broken terrain with thin soils than it is on flat or rolling terrain with thick soils.

Rate the sensitivity of a stream to disturbance by forest harvesting as low, medium or high based upon the preceding criteria (A to E).
2.913 Fisheries-value and Stream-sensitivity Ratings

Fisheries-value and stream-sensitivity ratings are represented by fisheries symbols (see Table 2-5). These symbols are placed along streams to identify the relative importance of streams to fish and the sensitivity of the streams to forest harvesting.

Table 2-5
Fisheries-value and stream-sensitivity ratings and fisheries symbols

<table>
<thead>
<tr>
<th>Fisheries-value and Stream-sensitivity Rating</th>
<th>Fisheries Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nil</td>
<td>▲</td>
</tr>
<tr>
<td>Low</td>
<td>■</td>
</tr>
<tr>
<td>Moderate</td>
<td>●</td>
</tr>
<tr>
<td>High</td>
<td>◆</td>
</tr>
</tbody>
</table>

Note: For unclassified streams, do not assign a fisheries symbol.

To determine the fisheries-value and stream-sensitivity rating of a stream, use the fisheries symbol matrix illustrated in Table 2-6.

Table 2-6
Fisheries symbol matrix

<table>
<thead>
<tr>
<th>Stream Sensitivity to Disturbance</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stream Value</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>▲</td>
<td>▲</td>
<td>■</td>
</tr>
<tr>
<td>Low</td>
<td>■</td>
<td>■</td>
<td>●</td>
</tr>
<tr>
<td>Medium</td>
<td>●</td>
<td>●</td>
<td>◆</td>
</tr>
<tr>
<td>High</td>
<td>●</td>
<td>◆</td>
<td>◆</td>
</tr>
</tbody>
</table>
For example, a stream reach having a stream-value-for-fisheries rating of low and a stream-sensitivity-to-disturbance rating of high would be assigned a moderate fisheries symbol.

For an example of the assignment of fisheries symbols to streams on forest cover maps, see Figure 2-6.

Note: Fisheries symbols may change over the length of a stream. For procedures on mapping, refer to Section 2.11.2.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Fisheries-value and Stream-sensitivity Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Symbol *</td>
<td>Nil</td>
</tr>
<tr>
<td>△</td>
<td>Low</td>
</tr>
<tr>
<td>■</td>
<td>Moderate</td>
</tr>
<tr>
<td>●</td>
<td>High</td>
</tr>
</tbody>
</table>

* No symbols along a stream on a forest cover map denote an unclassified stream.

Figure 2-6 Fisheries symbols

2.92 SOURCES OF INFORMATION

A. Ministry of Environment
   - Fisheries Branch
     Victoria and regional staff
   - Aquatic Studies Branch

B. Government of Canada
   - Fisheries and Oceans, Fisheries Service, Vancouver and district staff

C. Licensed outfitters and guides
2.10. E.S.A. FIELD PROCEDURES

Obvious and marginal E.S.A.s are identified first on the typed air photos and then confirmed, modified or deleted after ground or air examination or after local input. Also, during field work additional E.S.A.s may be identified that were not delineated during pretyping.

2.10.1 E.S.A. FIELD WORK FROM THE AIR

Air classification is done from low-level helicopter flights with the aid of air photos. Several photo scales are available and various types of flight plan can be used.

2.10.11 Selection of Photo Scale

Each photo scale has advantages and disadvantages for E.S.A. flight plans. The best scale for an area depends upon the frequency, complexity and distribution of E.S.A.s, the size of the area, and the quality of the photos available.

A. 1:15 840 (20 chain) and 1:20 000

These scales are good for accurate, detailed studies of E.S.A.s. However, at these scales, a large number of photos is required for each flight plan, which increases assembly time and complicates navigation.

B. 1:63 360 (80 chain)

1:63 360 (80 chain) photography is available for most of British Columbia. At this scale, few photos are required for each flight plan (perhaps eight to ten). This facilitates the assembly of flight plans and simplifies navigation. However, delineation of E.S.A. boundaries is less precise on 1:63 360 photos than on 1:15 840 or 1:20 000 photos.

C. 1:31 680 (40 chain) and 1:40 000

These scales are an excellent compromise for E.S.A. classification and are highly recommended.

2.10.12 Types of Flight Plan

The two types of flight plan are formal and informal. The type of flight plan chosen depends upon the scale and quality of photos available and the frequency, complexity and distribution of E.S.A.s:
A. Flight plans on 1:15 840, 1:20 000, and 1:31 680 scale typed photos

1. Formal flight plan

Denote on the typed classification photos air calls over all categories of E.S.A.s proposed in the unit. Assemble these air calls into a formal flight plan. Make inflight informal observations while ferrying between these formal air calls.

2. Informal flight plan

This is basically an observation flight with an occasional formal air call. Select a flight path on the typed photos that permits the observation and description of as many potential E.S.A.s as possible.

B. Flight plans on 1:63 360 (80 chain) or 1:40 000 scale photos

Select a flight route on the 1:63 360 or 1:40 000 photos. Transfer the proposed E.S.A. boundaries occurring along this flight path from the typed 1:15 840 or 1:20 000 photos to the 1:63 360 or 1:40 000 photos and fly an informal flight plan. Formal air calls may be made by inserting 1:15 840 or 1:20 000 photos into the flight plan for each formal air call to enable a precise identification and description of the area.

Flight Plan Preparation

Flight plans must be designed to maximize productive flying time and to allow rapid, yet accurate observations. Flight plan design depends upon topography, E.S.A. characteristics, available flying time, and type of helicopter.

These steps are suggested for the preparation of flight plans (see Figure 2-7):

A. Divide the work unit into logical flight plan units.

B. Prepare a closed circuit flight plan for each flight plan unit. A flight plan should not require more than 3.25 hours to fly, inclusive of ferry time. Also, cover the full scope of E.S.A. problems over a range of elevations.

C. To assist in navigation, highlight topographic features that occur along the flight path in yellow. Use clear, consistent symbols and mark only those features that will be visible from the helicopter and are not distinguishable on the photos without stereoscopic viewing, such as knolls and small ridges.

D. For safety, establish a radio check point for every 15 minutes of flying time.
E. Give each E.S.A. flight plan a number and record the number on each photo in the flight plan beside the permanent air photo number. Also, number each flight plan photo consecutively from one in the top northwest corner.

F. Establish good photo ties (connections) between photos along the flight path.

G. Prepare a flight plan map for the operational base that shows flight plan routes, air call locations, and radio check points.

Note: For a detailed description of flight plan preparation, refer to Chapter 3.

2.10.14 Flight Procedures

Except where safety is a factor, the classifier indicates the best position and speed of the helicopter for observation and navigation. The most effective speed for flying E.S.A. flight plans is between 80 and 110 kilometres an hour. For details on flight procedures, refer to Chapter 3.

During an E.S.A. flight plan, the classifier:

A. Makes formal air calls and/or observations during which he identifies and confirms E.S.A.s (see Sections 2.3 through 2.8). He records air calls and observations on a tape recorder and cross-references them to the air photo using consecutive numbers or symbols.

B. Identifies local air photo features to be used as stereograms to aid in the photo interpretation of E.S.A.s in areas that will not be checked from the air.

C. Measures a range of slope angles in each drainage using a clinometer. The helicopter must be level and flying straight when taking slope measurements (see Appendix 2-2, which is a conversion table for degrees and percent).

D. Records a number of elevations in each drainage.

E. Takes 35 mm photographs of typical E.S.A.s in the unit and for each photograph he notes the frame number, photo location and direction taken on the air photo and records the descriptive details on tape.
Pre-typed E.S.A. and inoperable area to be checked during flight plan.

Figure 2-7 E.S.A. flight plan photo (1:63 360)
Post-flight Procedure

After completing the flight plan, immediately transfer under stereo the tape-recorded information to the flight plan photos. By doing this, the classifier best remembers the flight plan, confirms or corrects the location of recorded data, recalls additional information not tape-recorded, and improves his photo-interpretative skills.

Summarize and store the collected information as follows:

A. Observations (see Figure 2-8)

Transfer observations directly from the tape to the flight plan photo location. Record the information neatly in ink (a "Dart II" pen is recommended for 1:63 360 and 1:40 000 photos). Place emphasis on:

1. Confirmed E.S.A.s
2. Marginal E.S.A.s that do not meet criteria
3. Slopes
4. Elevations
5. Significant landforms
6. Fish barriers
7. Important recreational and landscape features
8. Location, direction and reference number of each 35 mm photo taken, with a separate, detailed description of each one.

B. E.S.A. air calls

Summarize the air call information on the flight plan photos. Complete an E.S.A. assessment form (F.S. 804, see Appendix 2-6) for each formal air call.

C. Written summary

Write a brief summary of each E.S.A. flight for use in the writing of the E.S.A. summary in the E.S.A. report (see Section 2.12.).

E.S.A. FIELD WORK FROM THE GROUND OR WATER

Check as many E.S.A.s as feasible from the ground and from the water by making E.S.A. ground calls (F.S. 804) or by confirming and/or modifying E.S.A.s directly on the air photos.
Figure 2-8 E.S.A. flight plan photo (1:63 360) with recorded information
2.10.3 GROUND SAMPLES AND CLASSIFICATION GROUND CALLS AND AIR CALLS

E.S.A. information and site details are also collected on ground samples, classification ground calls, and classification air calls.

2.10.4 DOCUMENTATION OF E.S.A. FIELD WORK

Record E.S.A. air calls and E.S.A. ground calls on the even-numbered classification photos and on the forest cover maps as follows:

A. E.S.A. air call

\[ xE7-2(78) \]

- \( x \) - Centre of air call
- \( E \) - Prefix for E.S.A.
- \( 7 \) - E.S.A. flight plan number
- \( 2 \) - E.S.A. air call number
- \( 78 \) - Year of flight plan

B. E.S.A. ground call

\[ xGE-17(79) \]

- \( x \) - Centre of ground call
- \( G \) - Prefix for ground call
- \( E \) - Prefix for E.S.A.
- \( 17 \) - E.S.A. ground call number
- \( 79 \) - Year of survey
2.11. E.S.A. LABELS AND SYMBOLS

2.11.1 LABELLING

E.S.A. categories are represented by the symbols summarized in Table 2-7. For the wildlife category, the specific wildlife species is further identified by the symbols summarized in Table 2-8.

Table 2-7
Symbols for E.S.A. categories

<table>
<thead>
<tr>
<th>E.S.A. Category</th>
<th>Symbol</th>
<th>Forest Cover Map Symbol*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil</td>
<td>$E_{s1}$ or $E_{s2}$</td>
<td>$E_{s}$ or $E_{2s}$</td>
</tr>
<tr>
<td>Forest regeneration</td>
<td>$E_{p1}$ or $E_{p2}$</td>
<td>$E_{p}$ or $E_{2p}$</td>
</tr>
<tr>
<td>Snow avalanche</td>
<td>$E_{a}$</td>
<td>$E_{a}$</td>
</tr>
<tr>
<td>Recreation</td>
<td>$E_{r1}$ or $E_{r2}$</td>
<td>$E_{r}$ or $E_{2r}$</td>
</tr>
<tr>
<td>Wildlife</td>
<td>$E_{w1}$ or $E_{w2}$</td>
<td>$E_{w}$ or $E_{2w}$</td>
</tr>
<tr>
<td>Water</td>
<td>$E_{h1}$ or $E_{h2}$</td>
<td>$E_{h}$ or $E_{2h}$</td>
</tr>
</tbody>
</table>

* Note that the E.S.A. symbols in this column (except $E_{a}$) are used only on forest cover maps and are different from those used throughout this chapter.

Table 2-8
Symbols for wildlife species

<table>
<thead>
<tr>
<th>Wildlife Species</th>
<th>Symbol*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grizzly bear</td>
<td>b</td>
</tr>
<tr>
<td>Caribou</td>
<td>c</td>
</tr>
<tr>
<td>Deer</td>
<td>d</td>
</tr>
<tr>
<td>Elk</td>
<td>e</td>
</tr>
<tr>
<td>Goat</td>
<td>g</td>
</tr>
<tr>
<td>Moose</td>
<td>m</td>
</tr>
<tr>
<td>Birds</td>
<td>o</td>
</tr>
<tr>
<td>Sheep</td>
<td>s</td>
</tr>
<tr>
<td>Endangered or threatened species</td>
<td>t</td>
</tr>
</tbody>
</table>

*Note that these symbols are written as subscripts in the E.S.A. label.*
2.11.1 cont.

Important grizzly bear habitats along salmon producing streams bordered by productive forest are identified with symbols as shown in Figure 2-9.

![Figure 2-9 Grizzly bear symbols along salmon streams](image)

E.S.A. designations form part of the descriptive label of a forest type and are recorded at the end of the label.

Example: Pl7F3 161-26.8-6 Eplw2d

When designating E.S.A.s, consider these points:

A. Forest types may be separated on the basis of their having different E.S.A. designations only (see Figure 2-10).

![Figure 2-10 Forest types separated by different E.S.A.s only](image)

B. E.S.A. delineations should not create new types that are smaller than the recommended minimum type sizes (approximately 1.5 cm² and 1.0 cm² for forest and non-forest land, respectively).

C. E.S.A.s are delineated whenever forest classification labels exist regardless of park, park reserve and Indian reserve boundaries and other cadastral lines; that is, E.S.A. designations do not stop at or follow hatched map boundaries.

D. Alpine forest and non-productive forest types are given an E.S.A. designation, when justified.
E. E.S.A. designations may be made in non-forest areas such as for wildlife. However, make such designations sparingly and only when justified by high actual or potential resource use.

F. The use of E.S.A. subscripts is as follows:

1. A subscript 1 or 2 is always written for the soil, forest regeneration, recreation, wildlife and water categories because they can be in the high or moderate E.S.A. class:

\[ E_{s1}, E_{r1}, E_{r1}, E_{w1} \text{ and } E_{h1} \]
\[ E_{s2}, E_{p2}, E_{r2}, E_{w2} \text{ and } E_{h2} \]

2. The subscript 1 is assumed but not written for the snow avalanche category (Ea) because it is always in the high E.S.A. class.

G. Some areas have several interrelated resource values and/or environmental sensitivities, and require designation of more than one E.S.A. category. Express more than one E.S.A. category as dual or multiple E.S.A. symbols.

Guidelines for the assignment of dual or multiple E.S.A. symbols are:

1. A second category is added only when all the criteria for designation of a second category are met. Occasionally, up to three E.S.A. categories are allowed in a label.

2. E.S.A. categories in the high E.S.A. class always appear before E.S.A. categories in the moderate E.S.A. class, for example, \( E_{s1r2}, E_{aw2}, E_{r1w2}, E_{s1r2w2} \).

3. The order of importance in which E.S.A. categories in the same E.S.A. class are listed is: \( s, a, p, h, r, w \).

For example: \( E_{s1r1}, E_{ap1}, E_{s1h1w1}, E_{s2p2}, E_{p2r2w2} \).

The preceding order of importance must be used when determining the availability of timber and the conditions for harvesting it.

In the past, constraints on harvesting have been attributable to the first category listed in the multiple symbol. It is important that this philosophy be maintained.

2.11.2 FISHERIES SYMBOLS

Fisheries symbols placed along streams indicate the value to fish and the sensitivity to harvesting (see Table 2-9).
Table 2-9
Fisheries-value and stream-sensitivity ratings and fisheries symbols

<table>
<thead>
<tr>
<th>Fisheries-value and Stream-sensitivity Rating</th>
<th>Fisheries Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nil</td>
<td>▲</td>
</tr>
<tr>
<td>Low</td>
<td>■</td>
</tr>
<tr>
<td>Moderate</td>
<td>●</td>
</tr>
<tr>
<td>High</td>
<td>●◆</td>
</tr>
</tbody>
</table>

Note: Unclassified streams are not assigned a fisheries symbol.

These symbols are placed along streams on forest cover maps. For examples, see Figure 2-11.

Figure 2-11 Placement of fisheries symbols along streams

Use these procedures to map fisheries symbols along streams:

A. Make all symbols the same size and draw them on a horizontal plane.

B. If a stream crosses an entire map sheet and the fisheries-value and stream-sensitivity rating remains unchanged along it, show fisheries symbols at the edge of the map only (see Figure 2-12).
2.11.2 cont.

Figure 2-12 One fisheries symbol across an entire map sheet

C. Indicate a change in fisheries symbols as illustrated in Figure 2-13.

Figure 2-13 Different fisheries symbols along a stream

D. When a fisheries symbol continues onto an adjoining map, place a symbol at the edge of each map sheet where they tie (see Figure 2-14).

Figure 2-14 Tying of fisheries symbols to adjoining maps
E. Place fisheries symbols where streams enter and leave lakes (see Figure 2-15). Do not place fisheries symbols in lakes.

Incorrect

Correct

Figure 2-15 Fisheries symbols where streams enter and leave lakes

F. For widenings in a stream such as natural ponds and beaver ponds, do not assign additional symbols (see Figure 2-16).

G. To indicate blockages to fish passage in a stream on forest cover maps, use the waterfall symbol (see Figure 2-16).

Figure 2-16 Fisheries symbols where streams widen

H. Where a stream diverges into back or side channels, do not assign fisheries symbols to these channels unless the fisheries-value and stream-sensitivity rating is different (see Figure 2-17).

Figure 2-17 Fisheries symbols for side channels and back channels
2.12.  

E.S.A. REPORT

The object of the E.S.A. report is to have a record of the E.S.A. survey. Information recorded, in this suggested format, should include:

A. Title Page

- Name of unit (T.S.A., P.S.Y.U. or sub-unit)
- Year of E.S.A. survey
- Organization and personnel responsible for the E.S.A. survey

B. Introduction

1. Background
   - Date of forest classification
   - Date(s) of previous environmental survey(s)

2. Unit description
   - Description of the unit by geography (location, size, drainages and settlements), by biogeoclimatic zone, by climate (temperature and precipitation), and by physiography (topography, geology, landforms and surficial materials)

C. Methods

1. Pre-field procedures
   - Training received (Chapter two, Forest Inventory Manual, photo interpretation and specialist discipline)
   - Photo scale(s) and date(s) of aerial photography used
   - Method of E.S.A. pre-selection

2. Field procedures
   a) Ground work
      - Training received
      - Methods of E.S.A. delineation, verification and recording of information (observations and E.S.A. ground calls)

   b) Air work
      - Training received
      - Scale(s) and date(s) of aerial photography used
      - Type of helicopter
      - Methods of E.S.A. delineation, verification and recording of information (observations and E.S.A. air calls)

   c) Post-field procedures
      - Methods of E.S.A. finalization (approval meetings)
2.12 cont.

d) Sources of information
- Names of contributors to the E.S.A. survey (Ministry staff, provincial and federal agencies, forest companies, private citizens' groups, and individuals)

D. Results

1. Labour distribution summary

a) Pre-field work
- Man-days spent on training, data collection, liaison and on E.S.A. pre-selection
- Total man-days

b) Field work
(1) Ground work
- Man-days spent on training and on observations and E.S.A. ground calls
- Total man-days

(2) Air work
- Man-days spent on training, flight plan assembly, flights and on post-flight plan procedures
- Total man-days

c) Post-field work
- Man-days spent on finalization of E.S.A. designations and on E.S.A. report writing
- Total man-days

2. Field work summary
- Number of E.S.A. ground calls (F.S. 804)
- Number of flight plans
- Number of hours flown
- Number of E.S.A. air calls (F.S. 804)

3. E.S.A. summary

a) Topographic map showing unit boundaries

b) E.S.A. flight plan map (routes and locations of air calls).

c) Summary of environmentally sensitive areas by E.S.A. category and E.S.A. class and of fisheries by fisher symbol. This summary may be made by drainage or by assigned work area, if appropriate.
d) Collection of 35 mm photographs illustrating typical E.S.A.s.

e) E.S.A. summary map (reduced forest cover map of 1:50 000, 1:63 360 or 1:125 000 scale on which E.S.A. categories are illustrated using the standard colour codes in Table 2-10; the high and moderate E.S.A. classes are distinguished only on this map by the symbols E1 and E2, respectively; and the fisheries-value and stream-sensitivity ratings are shown by fisheries symbols along the streams).

Table 2-10

Colour codes by E.S.A. category for summary map

<table>
<thead>
<tr>
<th>E.S.A. Category</th>
<th>E.S.A. Symbol</th>
<th>Standard Colour Code</th>
<th>&quot;Mongol&quot; Pencil Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil</td>
<td>Es</td>
<td>Brown</td>
<td>963</td>
</tr>
<tr>
<td>Forest regeneration</td>
<td>Ep</td>
<td>Yellow-green</td>
<td>948</td>
</tr>
<tr>
<td>Snow avalanche</td>
<td>Ea</td>
<td>Yellow</td>
<td>967</td>
</tr>
<tr>
<td>Recreation</td>
<td>Er</td>
<td>Light blue</td>
<td>945</td>
</tr>
<tr>
<td>Wildlife</td>
<td>Ew</td>
<td>Green</td>
<td>968</td>
</tr>
<tr>
<td>Water</td>
<td>Eh</td>
<td>Dark blue</td>
<td>965</td>
</tr>
</tbody>
</table>

E. Appendices

1. Contributing reports to this E.S.A. report by biologists, pedologists and by other specialists.

2. Comprehensive list of references by E.S.A. category.
In 1973, environmental classification was introduced in the reinventory of several public sustained yield units (P.S.Y.U.). Productive forest land was stratified into two classes: productive forest land with or without restrictions on harvesting (environmental protection forest, E.P.F.).

The E.P.F. classification system was used from 1973 to 1975 using these categories: soil (Es), management (Ec), recreation (Er), wildlife (Ew), and occasionally fisheries (Ef) (see Table 2-11).

Table 2-11
1973-to-1975 E.P.F. categories

<table>
<thead>
<tr>
<th>E.P.F. Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Es</td>
<td>Areas having soils sensitive to forest harvesting</td>
</tr>
<tr>
<td>Er</td>
<td>Areas having high value for recreation</td>
</tr>
<tr>
<td>Ew</td>
<td>Habitats critical to the survival of fish and wildlife</td>
</tr>
<tr>
<td>Ec</td>
<td>Areas having specific limitations (forest regeneration, snow avalanche areas, water, and operability)</td>
</tr>
<tr>
<td>Ef</td>
<td>Areas providing protection to fish (used occasionally)</td>
</tr>
</tbody>
</table>

In 1976, categories for regeneration, snow avalanche, water and for operability were added and the classification system was renamed the environmental protection area (E.P.A.) system (see Table 2-12). Since 1981, inoperable areas (I) have been considered under the forest classification system (see Chapter 3) rather than under the environmental classification system because their delineation is based on physical barriers or limitations to harvesting and not on environmental sensitivity. In 1984, moderate E.S.A. classes were added to the E.S.A. categories of soil and forest regeneration.
### Table 2-12
1976 E.P.A. categories

<table>
<thead>
<tr>
<th>E.P.A. Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Es</td>
<td>Areas having soil and steepness problems</td>
</tr>
<tr>
<td>Ep</td>
<td>Areas having regeneration problems</td>
</tr>
<tr>
<td>Ea</td>
<td>Areas requiring avalanche protection</td>
</tr>
<tr>
<td>Er</td>
<td>Areas having value for recreation</td>
</tr>
<tr>
<td>Ew</td>
<td>Areas providing protection to wildlife resources</td>
</tr>
<tr>
<td>Eh</td>
<td>Community water sources and watersheds</td>
</tr>
<tr>
<td>Fisheries</td>
<td>Areas providing protection to fisheries resources</td>
</tr>
<tr>
<td>Ei</td>
<td>Areas having operability problems</td>
</tr>
</tbody>
</table>

From 1973 to 1978, E.P.F.s and E.P.A.s were separated from areas having no environmental classification by continuous lines drawn on the typed photos and on forest cover maps. The resultant E.P.F. or E.P.A. delineations were considered as independent types. In 1979, E.P.A. categories were added to the basic attribute description of a forest type and continuous E.P.F. or E.P.A. lines were no longer used.

To date, most of the province has been classified for environmental sensitivity and other resource values (excluding the Kechika, Alsek, Dease, Stikine, Taku, Boundary and Klappan P.S.Y.U.s in the northwest). These classifications are reviewed periodically, usually during standard unit and sub-unit reinventories or updates and are updated to correspond with the current E.S.A. classification standards.

This section contains instructions for the updating of E.P.F.s and E.P.A.s assigned between 1973 and 1982. Because the guidelines changed from year to year, the year of classification for environmental sensitivity by unit is shown in Appendix 2-7.
2.13.1 INSTRUCTIONS

A. Verify the locations of the original E.P.F. or E.P.A. designations and change them only when justified.

B. Make original E.P.F. or E.P.A. designations compatible with the present E.S.A. guidelines.

C. Re-examine the Ec category (1973 to 1975) and replace it with an Ep1 or Ep2, Ea, Eh1 or Eh2, or I (inoperable) when justified.

D. Add Es2 designations

E. Add the pertinent E.S.A. designation to the end of the descriptive label of each type.

F. Correct the mapping problems resulting from continuous E.P.F. or E.P.A. lines (see Figure 2-18) by:
   1. Removing very small E.P.F.s or E.P.A.s.
   2. Removing E.P.F. or E.P.A. lines cutting across non-productive types, which were used to separate environmentally sensitive areas from those having no E.P.F. or E.P.A. designations.

G. Add E.S.A. symbols to unproductive forest land (alpine forest and non-productive forest types), when justified.

Figure 2-18 Removal of unnecessary E.P.F. or E.P.A. lines
2.13.2 UPDATING BY YEAR OF ENVIRONMENTAL SURVEY

2.13.21 1973-to-1975 E.P.F.s

Es - Verify the original delineations and usually reclassify as Es1.
  - Add Es2 designations.

Ec - Verify the location and reclassify as Ep1 or Ep2, Ea, Eh1 or Eh2, or I (inoperable) when justified.

Er - Classify as Er1 or Er2

In some units Er lines may have been drawn around parks and reserves. Adjust these lines by delineating only those areas warranting an Er designation within the parks and reserves.

Ew - Classify as Ew1 or Ew2
  - Add wildlife-species subscripts.
  - Remove Ew lines placed along streams to protect fisheries habitats.
  - Add fisheries symbols.
  - Add grizzly bear symbols.

Ef - Remove Ef lines and replace with fisheries symbols.

2.13.22 1976 E.P.A.s

Es - Verify and usually reclassify as Es1.
  - Add Es2 designations.

Ep - Verify and classify as Ep1 or Ep2.

Ea - Verify.

Ei - Replace Ei with I for inoperable.

Er - Classify as Er1 or Er2.

Ew - In 1976 Ew was classified as Ew or Ew1:
  - Ew - usually reclassify as Ew2.
  - Ew1 - probably leave as Ew1.
  - Add wildlife-species subscripts.
  - Add grizzly bear symbols.

Eh - Classify as Eh1 or Eh2.

Fisheries - Convert 1976-to-1977 fisheries symbols to present symbols (see Table 2-13).
Table 2-13
Conversion of 1976-to-1977 fisheries symbols

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Unclassified</td>
<td>Blank</td>
<td>Blank</td>
</tr>
<tr>
<td>Nil</td>
<td>Category not used</td>
<td>▲</td>
</tr>
<tr>
<td>Low</td>
<td>▲</td>
<td>■</td>
</tr>
<tr>
<td>Moderate</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>High</td>
<td>■</td>
<td>←</td>
</tr>
</tbody>
</table>

2.13.23 1977 E.P.A.s
- Verify and usually reclassify as Es1.
- Add Es2 designations.

Ep
- Verify and classify as Ep1 or Ep2.

Ea, Er1, Er2, En, Eh2
- Verify.

Ei
- Replace Ei with I for inoperable.

Ew1, Ew2
- Add wildlife-species subscripts.
- Add grizzly bear symbols.

Fisheries
- Convert 1976-to-1977 fisheries symbols to present ones (see Table 2-13).

2.13.24 1978 E.P.A.s
- Verify and usually reclassify as Es1.
- Add Es2 designations.

Ep
- Verify and classify as Ep1 or Ep2.

Ea, Er1, Er2, En, Eh2, fisheries
- Verify.

Ei
- Replace Ei with I for inoperable.
2.13.25  1979-to-1980 E.P.A.s

Es
- Verify and usually reclassify as Es1.
- Add Es2 designations.

Ep
- Verify and classify as Ep1 or Ep2

Ea, Er1, Er2, Eh1 Eh2, fisheries
- Verify.

Ei
- Replace Ei with I for inoperable.

Unproductive forest types
- Ensure E.P.A. designations made in alpine forest and non-productive forest types are justified.

2.13.26  1981-to-1982 E.P.A.s

Es
- Verify and usually reclassify as Es1.
- Add Es2 designations.

Ep
- Verify and classify as Ep1 or Ep2

Ea, Er1, Er2, Eh1 Eh2, fisheries
- Verify.

Unproductive forest types
- Ensure E.P.A. designations made in alpine forest and non-productive forest types are justified.
CHAPTER TWO
ENVIRONMENTALLY SENSITIVE AREAS

APPENDICES
APPENDIX 2-1

MOVEMENT OF SURFICIAL MATERIALS BY GRAVITY

INTRODUCTION

Downhill movement of rock and soil caused by the force of gravity is the most universal of all processes of erosion. Such mass movement mechanisms as landslides, slumps, earthflows, sheet wash, soil creep, and subsidence in combination with transportation by running water, glaciers, wave action, wind, ground water, and sea currents are responsible for most erosion. No matter where one is, one does not have to look far to find evidence of mass movement. Principles governing it are simple, but the variety of combinations of types of movement, of materials moved, and of geomorphic forms assumed by these masses is great.

The driving force behind all mass movement is the force of gravity. This force is directed toward the center of the earth, but components of it act along any inclined plane. The steeper the inclination, the greater will be the component of force acting down the slope. This force is most effective in moving materials that are unstable in their existing position, such as on surfaces over which they might slide, for example, fractures or bedding planes.

Downslope movements are of great importance locally and in combination with streams that are responsible for much long-distance transportation. Downslope movements occur under all climatic conditions - in the air and under the waters of the oceans. Mass movement is even significant on the moon where there is neither atmosphere nor water.

Not only natural mass movements and resultant dangers are important to man; instability may be induced in rock and earth masses by our own modifications of the natural environment. As use of land is intensified, it becomes increasingly difficult to avoid areas where potential natural mass instability exists - areas where floods, wave actions, or earthquakes may trigger disastrous mass movements. Engineers must take great care to circumvent costly mass movements in their planning and construction of building foundations, dams, reservoirs, bridge abutments, tunnels, and in their design of cuts and fills along highways and canals. Costly and sometimes even disastrous results have followed where the dangers of potential mass movement have not been fully recognized or efforts to meet the danger have been too limited.
CLASSIFICATION OF MASS MOVEMENT

Numerous classifications of mass movements have been proposed. These are based on the type of material moved, the rate of movement, the presence or absence of water, or the mechanisms of movement.

In reference to materials moved, the terms rock, earth, soil, debris, and mud are commonly used:

Rock - Solid rocks and consolidated fragmental rocks.

Earth - General term used to describe disintegrated rocks and loosely consolidated sediments.

Soil - Product of rock disintegration and decomposition by weathering modified by biological agents; capable of supporting plant life.

Debris - General term applied to mixtures of rock, soil, plant matter or mud.

Mud - Mixture of water and the finer particles of earth and soil.

Movements may take place through sliding along some surface or through an internal rotation of constituent particles, resulting in general flowage of the entire mass. Sliding is promoted by the existence of faults, fractures, bedding planes, and other planes of weakness. When these are inclined downslope, the material above can move along them. Flowage is a much more complicated process, involving rotation, slippage, or sliding of the materials inside the moving mass. Flowage of masses may take place slowly in nearly imperceptible movements called creep or at velocities of up to 96 kilometres an hour, as in debris avalanches. Flowage is possible in dry masses, but high water or ice contents have pronounced effects on the nature and velocity of the flow.

The following classification devised by Sharpe (1938) is widely used. It separates the major categories on the basis of rate and type of movement, and subdivisions are made on the basis of the type of material moved:

A. Slow flowage
   - Rock creep
   - Talus creep
   - Soil creep
   - Rock-glacier creep
   - Solifluction

B. Rapid flowage
   - Earthflow
   - Mud flow
   - Debris avalanche
C. Sliding

- Slump
- Debris slide
- Debris fall
- Rockslide
- Rockfall

D. Subsidence

CREEP

Evidence of the slow downhill movement of soil or unconsolidated sediment is apparent on close inspection of almost every hillside. Weathered remnants of rocks and boulders may be drawn out into long, lens-shaped masses by creep. The small, parallel rows, originally paths used by grazing animals, that circle many hillsides are signs of this creeping downslope movement. Fences and telephone poles set on slopes give indication of these surface movements as they slowly become inclined downhill. These observations of creep indicate that it takes place as a result of combinations of rotation of particles in the soil, drawing out of plastic materials, and probably other types of internal readjustments in surficial materials.

ROCKFALL AND TALUS ACCUMULATION

Cliffs are formed along recent fault scarps, where resistant beds are eroded by stream action, and many of the most spectacular bare-rock cliffs, some thousands of metres high, have been formed where valley glaciers have eroded and deepened stream valleys in high mountains. Freezing and thawing are very effective in loosening rock fragments from cliffs, and other weathering processes are also responsible for inducing rockfall, sometimes starting landslides. As this rock debris, called talus, reaches a lower slope, it piles up to form a cone-shaped feature called a talus cone. The cones may coalesce or, if rock fragments are not channeled into cones, a nearly continuous sheet of talus may form at the base of the cliff. Talus cones or sheets are composed of whatever rocks make up the face of the cliffs. Mechanical weathering on such steep slopes, particularly freezing and thawing, is so much more rapid than chemical decay that the talus rocks on top of the piles usually appear freshly broken. The broken blocks are of all sizes, but seldom have dimensions smaller than several centimetres. Talus may form anywhere rock outcrops are subjected to weathering and erosion over long periods of time, and where a cliff is above a lower slope from which removal of materials lags behind the rate of accumulation.
ROCK GLACIERS

On the floors of mountain valleys, talus may lie where it falls, moving at very slow rates and then only because it is disturbed by freezing and thawing, by animals, or by impact of new rocks falling on it. But if the valley floor is inclined, converging piles of talus may form a tongue-shaped projection down the valley. These lobes of talus move so slowly that their motion can be detected only by checking the position of the end of the lobe over a period of years. Such is the movement of the rock glacier. As a rock glacier advances it assumes garland-shaped loops, giving the appearance of a very viscous liquid. Some of these sheets have considerable amounts of ice mixed with rock making the movement of the rock glacier more rapid than that of glaciers at lower elevations and lower latitudes.

SOLIFLUCTION

This term, which literally means soil flowage, is applied to downslope movement of soils, rock debris, and other fragments in climates where the ground is solidly frozen in the winter and is only partially thawed in the summer months. When thawing occurs, upper layers of the soil, which have been forced up and deranged by frost heaving, are bathed in melt-water. Lower layers of the soil remain frozen. Water above the frozen layer lubricates the interface. This facilitates flowage and slow movement of the upper layers over the lower frozen layers, even on very low slopes. The moving mass of soil and debris takes sheet, lobate, or tongue-like forms as it moves. Where valleys are present, it will move into and down them. The nature of the debris depends upon the composition of the soil. On Bear Island in the North Atlantic the surface is covered with a thick flowing mud in the warm months, whereas in places on the Falkland Islands the debris is made up of quartzite fragments.

MUD FLOW

Mud flows occur most frequently in deserts where fine weathering products are dry most of the year. When rain does fall it often comes in large quantities, perhaps with a large part or all of the annual rainfall coming in a single rain. Water seeps into the weathering products, and the mixture gains momentum as it moves rapidly down steep slopes. These flows follow existing channels and gullies. Although a mud flow is not dry, the mass does not necessarily contain much free water. Sometimes even large boulders will float in the mud. Mud flows are favoured by intermittent water supply, lack of vegetation, and abundant unconsolidated rock debris.

Some of the most disastrous mud flows have occurred on the steep slopes of the San Gabriel Mountains of southern California. Mud flows there are often preceded by extensive forest fires that destroy the vegetative cover. One such flow started on a warm day when the heat caused melting of
the snow cover in the high mountains. Melt-waters percolated into the thick, weathered cover of decaying schists. When the weathered material became saturated, it broke loose, leaving a scar extending 300 metres up the mountainside with cliffs 46 metres high around the edge. The mud flow continued for five days and at its height splashed mud six metres into the air, leaving a mud coating on treetops. The mixture was about 25 percent water.

LANDSLIDE CLASSIFICATION

The Highway Research Board Landslide committee has proposed a classification of landslides (see Table 2-14) that includes most types of mass movement (Eckel, 1958). This classification is structured to bring out the interrelationships of the various factors involved in mass movements. It does not, however, differentiate such forms of movement as solifluction, creep, rock glacier, and talus accumulations, which are described separately.

LANDSLIDES

Landslides are "the downward and outward movement of slope-forming materials composed of natural rock, soils, artificial fills, and combinations thereof" (Eckel, 1958). Sharpe (1938) restricted the term landslide to relatively dry masses. The type of material involved is classified according to its state before initial movement or, if the type of movement changes, according to its state at the time of the change of movement.

The type of movement and type of material provide the primary basis for the classification, with the amount of moisture, the nature of the surface on which movement occurs, and the speed of movement allowing finer distinctions within the broader framework of the classification.

FALLS

Falls occur when the mass in motion travels most of the distance through the air. Falls included are free falls, bounces, and rolling of rock and debris fragments without much interaction of one fragment with another.

SLIDES

Slides include movements caused by finite shear failure along one or several surfaces. Figure 2-19 illustrates a debris slide where rock, soil and clay mixtures are sliding slowly to very rapidly over solid bedrock; Figure 2-20 illustrates a block glide (lateral spread) where blocks move slowly over a base with a low coefficient of friction (loess over clay); and Figure 2-21 illustrates a debris avalanche where dry to moderately wet debris is moving rapidly to extremely rapidly over bedrock. The mass may divide into a few
### Table 2-14
Classification of landslides, abbreviated version

<table>
<thead>
<tr>
<th>TYPE OF MATERIAL</th>
<th>SOILS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bedrock</td>
<td></td>
</tr>
<tr>
<td>Slides</td>
<td></td>
</tr>
<tr>
<td>Few Units</td>
<td>Rational Planar</td>
</tr>
<tr>
<td></td>
<td>Slump Block glide</td>
</tr>
<tr>
<td>Many Units</td>
<td>Rockslide Debris slide</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>All Unconsolidated</td>
<td></td>
</tr>
<tr>
<td>Rock Fragments</td>
<td></td>
</tr>
<tr>
<td>Dry Flow</td>
<td>Rock fragment run</td>
</tr>
<tr>
<td>Wet Flow</td>
<td>Rapid Debris Slow earthflow avalanche earthflow</td>
</tr>
<tr>
<td>Complex</td>
<td>Combinations of material or type of movement</td>
</tr>
</tbody>
</table>
or many units. When division is into only a few units, the material in motion is not greatly deformed. The movements may be controlled by surface of weakness such as fractures, faults, or bedding planes. The masses may move as a slump with movement along internal slope surfaces, which are usually concave upward, or as a block glide (lateral spread) movement (see Figure 2-20) in which the units move out and down along a more or less planar surface of weakness, for example, bedding, fractures, faults, or the original ground surface. The mass in movement may break down into many smaller units when it is intensively fractured or when thin beds are separated by zones of weakness. The size of the individual unit is comparable to, or less than, the displacements between units. Movements of such masses are likely to go beyond the original slip surface so that parts of the mass slide over the ground surface.

Figure 2-19 Debris slide

Figure 2-20 Block glide (lateral spread)
This designation is used when the form taken by the moving material or the apparent distribution of velocities and displacements resembles that of viscous flow. Figure 2-22 is of a debris flow and illustrates a very rapid flow of material (rock, soil and clay) which has a high water content; Figure 2-23 shows a rapidly moving sand or silt flow where the material is saturated with water; Figure 2-24 illustrates an earthflow of weathered shale where the flow is plastic; Figure 2-25 is of an extremely rapidly moving dry loess flow as it occurred in Kansu Province, China in 1920; and Figure 2-26 shows a rapidly moving earthflow of wet glacial clay and silt. Slip surfaces usually are either not visible or are temporary. The size of the individual particles in the moving mass is generally very small compared with the amount of movement.

<table>
<thead>
<tr>
<th>Speed</th>
<th>Movement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extremely rapid</td>
<td>3 metres a second or more</td>
</tr>
<tr>
<td>Very rapid</td>
<td>1.5 to 3 metres a second</td>
</tr>
<tr>
<td>Rapid</td>
<td>0.003 to 1.5 metres a second</td>
</tr>
<tr>
<td>Moderate</td>
<td>1.5 metres a month to 1.5 metres a day</td>
</tr>
<tr>
<td>Slow</td>
<td>0.3 to 1.5 metres a month</td>
</tr>
<tr>
<td>Very slow</td>
<td>0.3 metres in five years to 0.3 metres a month</td>
</tr>
<tr>
<td>Extremely slow</td>
<td>Less than 0.3 metres in five years</td>
</tr>
</tbody>
</table>
APPENDIX 2-1 cont.

Figure 2-22 Debris flow

Figure 2-23 Sand or silt flow

Figure 2-24 Earthflow
APPENDIX 2-1 cont.

Figure 2-25  Loess flow (dry)

Figure 2-26  Rapid earthflow of wet soil

PRINCIPLES GOVERNING MASS MOVEMENTS

The primary force involved in mass movement is the force of gravitational attraction, a body force that acts on every particle throughout the materials of the earth's crust. This force is directed downward toward the centre of the earth and it acts with nearly uniform magnitude on surficial material; yet some of these materials are so situated in their environment that they become unstable and move downslope while others remain stable. Chief among the factors influencing stability are:

A. Nature of the material
B. Structure of the material and its surroundings
C. Slope of the ground surface
D. Presence of water, ice, compressed air, or steam in the material
E. Presence or absence of stabilizing ground cover such as forests
The factors combine in a variety of ways to determine the degree of stability.

Streams, glaciers, and dry mass movements are all driven by gravity. One might reasonably expect to have little difficulty in distinguishing a stream from a glacier, and either of them from a dry mass movement but the distinction is not so clear-cut. Glaciers carry heavy loads of rock, soil, and debris; so do streams; and mass movement usually contains some proportion of water or ice. The three types of movement are represented in Figure 2-27 by a triangular diagram that is indicative of the gradational character of each. Figure 2-27 also shows the process of degradation through breakdown and transportation of the crust. Under the pull of gravity these decay products move downhill, transported dry, in water, in ice, and in combinations of these three.

Figure 2-27 Process of degradation

NATURE OF THE MATERIAL

Some earth materials are inherently strong, for example, massive granite, basalt and quartzite, where the mineral components of the rock form an interlocking network of crystals or where the fragments are tightly cemented together. The bonds between the particles of such rocks are more uniformly strong in all directions through the rock mass than is found in most sedimentary and metamorphic rocks. Weakness in such rock masses usually is caused by structures, for example, fractures, that may divide the massive rock into blocks. Among metamorphic rocks, planes of inherent weakness may arise as a result of compositional layering. Planes of foliation, schistosity, slaty cleavage, as well as fractures, are planes of weakness along which the rock may break.
The physical properties of sections of sedimentary rocks vary from layer to layer so that the layering generally imparts a plane of inherent weakness although individual strata may be uniformly strong in all directions. Some layers may be soluble, for example, limestone and gypsum; others may have open interconnected pore spaces, for example, sandstone and conglomerate; and some, like shale, may be cleaved or subject to expansion on wetting.

Unconsolidated sediment also has a wide range of physical properties. The stability of fragmental materials such as sand, silt, and pebbles is greatly influenced by the degree of sorting, the angularity of the particles, the degree of cementation, the porosity and presence of fluids in the pore spaces, and even the texture of the surfaces of the individual fragments. The stability of clay is closely related to the degree of saturation with water and to the weight of the overlying material.

The principles governing mass movement differ with the types of material involved. Some materials owe their weakness to the existence of planes of weakness along which parting or sliding is possible. Instability in such materials is increased by anything that tends to induce slip or parting along those planes. Each fragment is capable of movement in granular materials so processes or conditions that favour rotation, rolling or mass slipping may induce instability.

THE ROLE OF WATER

Water is usually present in the ground and it may play a crucial role in causing movement by one of the following mechanisms:

A. When clay colloids absorb water their plasticity is increased; the shearing resistance of wet clay is less than that of dry clay.

B. The chemical weathering of a number of common minerals is facilitated or caused by water, and clay is often a by-product of this weathering.

C. Water, especially rainwater, can dissolve rocks such as limestone and thus lead to reduced strength of the rock and to development of cavities and the opening of fractures.

D. Water may act as a lubricant, reducing the frictional resistance between surfaces or between points of contact between fragments.

E. When a granular mass is saturated with water, the water has a buoyant effect, reducing the effective weight of each submerged grain by the weight of the displaced volume of water.

F. Under some conditions water rising to the surface of the ground may be under pressure and will exert upward force on the material through which it moves.
APPENDIX 2-1 cont.

PROCESSES OF MOVEMENT

FALL

Free falls occur only on the steep slopes that are characteristic of massive rocks, such as igneous, metamorphic, and tightly cemented sedimentary rocks, although a few unconsolidated sediments may also stand in near-vertical cliffs. Rocks from the cliff may be broken off by frost, causing a face bounded by a fracture to fall away, or undercutting may simply proceed until the unsupported weight of the overhanging rock exceeds the breaking strength of the rock and it falls.

SUBSIDENCE AND COLLAPSE

Subsidence and collapse are significant forms of mass movement in areas where subsurface water is actively dissolving and removing rock, effectively undermining the surficial materials. Limestone, gypsum, salt, and anhydrite are the most common rocks that are likely to dissolve in quantities sufficient to produce large-scale subsidence or collapse; and of course the melting of ice frequently produces this result. Subsidence may also occur after the release of gas or the removal of large quantities of ground water or oil from reservoirs in unconsolidated or semi-consolidated sediment.

Subsidence is the gradual lowering of surface materials into space opened as result of removal of rock below. If the rock being removed is strong or if it is overlain by rock that is strong, a large cavity may be developed before failure takes place. Failure is likely to be sudden, followed by the collapse of the roof into the cave. When collapse occurs, the broken rock may form a coarse breccia but a crude layering may be preserved when subsidence takes place.

SLIDING ON A SURFACE

Sliding on a surface may be explained using a block on an inclined plane (see Figure 2-28). The weight of the block, which is directed down, may be resolved into two components - one acting down the inclined plane and the other perpendicular to the plane, which is counterbalanced by the push of the plane against the rock. If the block is not moving, the component of force directed down the plane, is counterbalanced by frictional resistance to such movement along the contact between the plane and the block. Instability can be induced by either increasing the inclination of the plane, (steepening the slope) or reducing the frictional forces between the plane and the block.

The slope can be increased in nature as a result of erosion or uplift; or man may cause the increase by removal of near-surface materials. The friction between the block and the plane is due to the nature of the surface, the presence of lubricants, and the weight of the block. The slope required for sliding is steep when the friction is great, but movements on very low slopes are possible when frictional resistance is low.
APPENDIX 2-1 cont.

Figure 2-28 Forces acting on a block on an inclined plane

The plane may be a fracture surface, a fault, a bedding plane, or the surface of the ground. The block may be a large or small rock, massive or not, bounded by joints or masses separated by erosion from their natural continuations. One of the most common and potentially dangerous situations in which this type of mass movement occurs is that found where steeply inclined strata or fractures dip in the same direction as the slope of the ground surface and are undercut in the valley by streams, glaciers, or highway construction. When undercutting penetrates massive rocks and cuts into shales or other rocks with low shearing resistance, failure is likely because most strata are fractured and these permit separation as part of the mass slides downslope. Water may enter the potential zone of movement through fractures, and if the potential slide zone contains clay, resistance to shear in the zone will be significantly reduced.

SLUMP

The term slump is applied to movements that involve a rotational shear type of sliding motion (see Figure 2-29). These often combine with other types of mass movement, earthflow or mud flow, slides, falls and so on, and are one of the most common types of mass movement. Movement in a slump is more or less rotational about an axis that is parallel to the slope. Movements take place on internal slip surfaces; these surfaces appear as cracks in the ground at the head of the slumping mass and usually have accurate form, being concave toward the slumping mass. The slump may assume a spoonlike shape, as is common when slumps occur in uniform granular material, or they may have a cylindrical form where the slip surface runs parallel to the slope for some distance. Several varieties of slump are illustrated in Figures 2-30 and 2-31; these differ in the nature of the internal slip surface and its relationship to the slope and to the structure of the slump mass. The slip surfaces tend to follow planes or zones of weakness, such as old soil surfaces where land fills have been placed, jointed surfaces, faults, clay or shale zones, and highly cleaved zones; all of these are
marked by low frictional resistance to sliding. Wetting may further reduce frictional resistance. Water flows into these zones of movement through cracks at the head of the slump, which pull open. As the slumping mass rotates, the surface is tilted and water is directed toward the open cracks.

Figure 2-29 Terms applied to parts of a landslide

Figure 2-30 Rotational slump in bedrock: slow to moderate movement
PLASTIC FLOW

Clay and clay mixtures are plastic; that is, they behave as elastic material if they are stressed below some limiting value, but if loaded beyond that limit they flow and deform continuously. Plastic behaviour can be induced either by adding load on the material or by changing the plasticity of the material, notably by adding water to it. Water seeping down along fractures or through pore spaces into a claystone or mudstone may make the clay more plastic and thereby induce plastic flow or sliding. Shale can be altered to clay by water; limestone can be dissolved by ground water, leaving clay residue; and fault breccias are subject to similar weathering effects. Plastic flow can be initiated by adding weight artificially, as has happened during road construction over salt beds in Utah, and over clay beds in the Coastal Plain. Failure of the Fort Peck Dam in Montana was attributed to swelling and plastic flow of clays under the dam when water accumulated in the reservoir and seeped down into the clay layers. Plastic flow in the clays under the Panama Canal was caused by excessive loading when dredged material was piled along the sides of the canal.

FAILURE OF GRANULAR MATERIALS

Uncemented granular materials assume slopes of a certain steepness if they are free to move. If the granular material is uniform, the slope of that material does not exceed a particular value, called the angle of repose, usually 30 to 40 degrees. That angle depends upon the shape of the fragments; rounded fragments tend to have lower angles of repose than do rough-smooth-surfaced fragments. The angle of repose is a function of the size of particles, the degree of sorting, the density of materials, and the amount of anhydrous constituents. In short, the angle of repose is essentially a reflection of the cohesiveness of the fragments.
FLUID FLOW

We find in nature a completely gradational transition from forms of entirely dry mass movement to stream flow. The behaviour of water in stream flow is true fluid flow of a viscous liquid. Liquids cannot support shear deformation; instead they move continuously under any applied shearing stress. The viscosity of a fluid is the internal friction or internal resistance the fluid offers to applied stresses. Because the viscosity of water is low, it cannot stand at different levels in a container or in a natural stream system. Fluid flow may be nearly laminar, in which one layer slips over another, or turbulent, in which the flow pattern of a particle of water follows an irregular path of swirls and loops. As the water content of soil or debris on a slope increases, the clay fraction absorbs water and the plasticity of the mass increases; the contacts between solid fragments are lubricated; and eventually, if the water content becomes very high the fragments are buoyed by the water. Under these conditions the mass flows in a manner analogous to a viscous liquid as the internal frictional resistance of the mass is reduced. Mud flows and solifluction are examples of this form of mass movement.

REFERENCES


APPENDIX 2-2
SLOPE CONVERSION CHART

<table>
<thead>
<tr>
<th>Slope (percent)</th>
<th>Angle (degrees)</th>
<th>Slope (percent)</th>
<th>Angle (degrees)</th>
<th>Slope (percent)</th>
<th>Angle (degrees)</th>
</tr>
</thead>
<tbody>
<tr>
<td>+ 0</td>
<td>+ 0</td>
<td>42</td>
<td>22.78</td>
<td>84</td>
<td>40.00</td>
</tr>
<tr>
<td>2</td>
<td>1.15</td>
<td>44</td>
<td>23.75</td>
<td>86</td>
<td>40.70</td>
</tr>
<tr>
<td>4</td>
<td>2.29</td>
<td>48</td>
<td>24.70</td>
<td>90</td>
<td>41.37</td>
</tr>
<tr>
<td>6</td>
<td>3.43</td>
<td>50</td>
<td>25.63</td>
<td>92</td>
<td>42.00</td>
</tr>
<tr>
<td>8</td>
<td>4.57</td>
<td>52</td>
<td>26.57</td>
<td>94</td>
<td>42.60</td>
</tr>
<tr>
<td>10</td>
<td>5.71</td>
<td>54</td>
<td>27.47</td>
<td>96</td>
<td>43.13</td>
</tr>
<tr>
<td>12</td>
<td>6.84</td>
<td>56</td>
<td>28.37</td>
<td>98</td>
<td>43.82</td>
</tr>
<tr>
<td>14</td>
<td>7.97</td>
<td>58</td>
<td>29.25</td>
<td>100</td>
<td>44.61</td>
</tr>
<tr>
<td>16</td>
<td>9.09</td>
<td>60</td>
<td>30.12</td>
<td>102</td>
<td>45.00</td>
</tr>
<tr>
<td>18</td>
<td>10.20</td>
<td>62</td>
<td>31.00</td>
<td>104</td>
<td>45.38</td>
</tr>
<tr>
<td>20</td>
<td>11.31</td>
<td>64</td>
<td>31.90</td>
<td>106</td>
<td>45.72</td>
</tr>
<tr>
<td>22</td>
<td>12.41</td>
<td>66</td>
<td>32.80</td>
<td>108</td>
<td>46.66</td>
</tr>
<tr>
<td>24</td>
<td>13.50</td>
<td>68</td>
<td>33.72</td>
<td>110</td>
<td>47.20</td>
</tr>
<tr>
<td>26</td>
<td>14.57</td>
<td>70</td>
<td>34.62</td>
<td>112</td>
<td>48.21</td>
</tr>
<tr>
<td>28</td>
<td>15.64</td>
<td>72</td>
<td>35.50</td>
<td>114</td>
<td>48.76</td>
</tr>
<tr>
<td>30</td>
<td>16.70</td>
<td>74</td>
<td>36.40</td>
<td>116</td>
<td>49.21</td>
</tr>
<tr>
<td>32</td>
<td>17.74</td>
<td>76</td>
<td>37.22</td>
<td>118</td>
<td>49.76</td>
</tr>
<tr>
<td>34</td>
<td>18.78</td>
<td>78</td>
<td>38.12</td>
<td>120</td>
<td>50.20</td>
</tr>
<tr>
<td>36</td>
<td>19.80</td>
<td>80</td>
<td>39.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>38</td>
<td>20.80</td>
<td>82</td>
<td>39.88</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 2-32 Relationship between angles in degrees and in percent
APPENDIX 2-3
EDATOPIC GRID AND ECOSYSTEM ASSOCIATIONS WITH INDICATOR PLANTS FOR THE ESSF8 BIOGEOCLIMATIC SUBZONE

SOIL NUTRIENT REGIME

<table>
<thead>
<tr>
<th>Soil Moisture Regime</th>
<th>Oligotrophic (Very poor)</th>
<th>Sub-mesotrophic (Poor)</th>
<th>Mesotrophic (Medium)</th>
<th>Permeotrophic (Rich)</th>
<th>Subeutrophic to eutrophic (Very rich)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very xeric (Excessively drained)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Xeric (Very rapidly drained)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subxeric (Rapidly drained)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Submesic (Well drained)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mesic (Moderately well drained)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subhygic (Imperfectly drained)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hygic (Poorly drained)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subhydric (Very poorly drained)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Legend:
- 0: Very xeric
- 1: Xeric
- 2: Subxeric
- 3: Submesic
- 4: Mesic
- 5: Subhygic
- 6: Hygic
- 7: Subhydric

Examples:
- 2: RHODODENDRON-RUBUS
- 3: RHODODENDRON-TIARELLA
- 4: OPLOPANAX-ATHYRIUM
- 5: RIBES-EQUISETUM
- 6: CAREX-SPHAGNUM
- 7: SALIX-DRYAS
APPENDIX 2-3 cont.

Table 2-15 is a list of indicator plant species for each of the ecosystem associations found in the ESSFb subzone (Nelson Forest Region). From left to right the columns of plants listed are shrubs (occasionally trees), herbs, and mosses and lichens.

Table 2-15
List of indicator plants for the ESSFb subzone

<table>
<thead>
<tr>
<th>SHRUBS</th>
<th>HERBS</th>
<th>MOSSES AND LICHENS</th>
</tr>
</thead>
<tbody>
<tr>
<td>RODODENDRON ALBIFLORUM - RUBUS PEDATUS</td>
<td>Rhododendron albiflorum Rubus pedatus</td>
<td>Barbilophozia lycopodioides</td>
</tr>
<tr>
<td>(White rhododendron - Five-leaved creeping raspberry)</td>
<td></td>
<td>Dicranum fuscescens</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pohlia Nutans</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>RODODENDRON ALBIFLORUM - TIARELLA UNIFOLIATA</td>
<td>Rhododendron albiflorum Gymnocalciuim dryopteris Rubus pedatus Streptopus roseus Tiarella unifoliata Valeriana sitchensis</td>
<td>Barbilophozia lycopodioides</td>
</tr>
<tr>
<td>(White rhododendron - Unifolate-leaved foamflower)</td>
<td></td>
<td>-------------------------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>LUZULA PARVIFLORA - DRYOPTERIS ASSIMILIS</td>
<td>Rhododendron albiflorum Dryopteris assimilis Gymnocalciuim dryopteris Luzula parviflora Streptopus roseus Tiarella unifoliata Valeriana sitchensis Veratrum viride</td>
<td>Barbilophozia lycopodioides</td>
</tr>
<tr>
<td>(Small-flowered woodrush - Spiny wood fern)</td>
<td></td>
<td>Mnium nudum</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
## APPENDIX 2-3 cont.

### SHRUBS | HERBS | MOSSES AND LICHENS

<table>
<thead>
<tr>
<th>Plant Name</th>
<th>Plant Name</th>
<th>Plant Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Menziesia ferruginea</td>
<td>Athyrium filix-femina</td>
<td>Brachythecium hylotapetum</td>
</tr>
<tr>
<td>Oplopanax horridus</td>
<td>Dryopteris assimilis</td>
<td>Mnium nudum</td>
</tr>
<tr>
<td>Ribes lacustre</td>
<td>Galium triflorum</td>
<td></td>
</tr>
<tr>
<td>Rubus parviflorus</td>
<td>Gymnocarpium dryopteris</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mitella breweri</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rubus pedatus</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Streptopus amplexifolius</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Streptopus roseus</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tiarella unifoliata</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Valeriana sitchensis</td>
<td></td>
</tr>
<tr>
<td>Menziesia ferruginea</td>
<td>Athyrium filix-femina</td>
<td>Brachythecium hylotapetum</td>
</tr>
<tr>
<td>Oplopanax horridus</td>
<td>Dryopteris assimilis</td>
<td>Mnium nudum</td>
</tr>
<tr>
<td>Ribes lacustre</td>
<td>Galium triflorum</td>
<td></td>
</tr>
<tr>
<td>Rubus parviflorus</td>
<td>Gymnocarpium dryopteris</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mitella breweri</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rubus pedatus</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Streptopus amplexifolius</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Streptopus roseus</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tiarella unifoliata</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Valeriana sitchensis</td>
<td></td>
</tr>
<tr>
<td>Ribes lacustre</td>
<td>Equisetum arvense</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gymnocarpium dryopteris</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Senecio triangularis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Streptopus amplexifolius</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Streptopus roseus</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Valeriana sitchensis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Veratrum viride</td>
<td></td>
</tr>
<tr>
<td>Carex spectabilis</td>
<td>Carex spectabilis</td>
<td>Sphagnum capillaceum</td>
</tr>
<tr>
<td></td>
<td>Mitella breweri</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Streptopus roseus</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vanhœdea atropurpurea</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Veratrum viride</td>
<td></td>
</tr>
<tr>
<td>Salix barclayi</td>
<td>Dryas drummondii</td>
<td>Cladonia chlorophaea</td>
</tr>
<tr>
<td>Shepherdia canadensis</td>
<td>Fragaria virginiana</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Orthilia secunda</td>
<td></td>
</tr>
</tbody>
</table>
INTRODUCTION

In British Columbia's mountainous and snowy terrain, snow avalanches are commonplace. The destructive potential of tons of snow moving down steep slopes at speeds which may exceed 250 kilometres an hour ranks with the effects of flooding, fires and earthquakes. By means of land-use planning, however, some protection may be afforded to people, man-made structures, and natural resources.

Snow on a slope always has a tendency to move downhill. Slope failure occurs if the stress exceeds the strength and friction within the snowpack and the support provided by trees and terrain irregularities. Snow then behaves fluidly and tends to be channelled by topography. Five types of motion may be distinguished:

A. Powder avalanches
   An aerosol of snow dust 2 to 20 times denser than air; little influenced by obstacles; speed 20 to 70 metres a second.

B. Dry flowing avalanches
   Dry snow which moves along ground; not influenced by small terrain irregularities; speed 15 to 60 metres a second.

C. Wet flowing avalanches
   Dense, wet snow readily deflected by terrain features; speed 5 to 30 metres a second.

D. Mixed avalanches
   A combination of powder and dry flowing types usually on steep terrain.

E. Air Blast
   An air pressure wave which precedes a few avalanches and which has sufficient strength to destroy forest stands and move structures.

The information required for protection against avalanches by means of land-use planning includes:

- Regional snow climate.
- Maximum and average slope angles of the avalanche start zone.
APPENDIX 2-4 cont.

- Shape of the avalanche track (the longitudinal and cross sectional profiles).
- Evidence of activity in the area based on vegetation analysis.

The next sections will discuss these factors in greater detail.

CLIMATE

The most important factors affecting the distribution of snow and avalanche activity are:

A. Frequency and magnitude of snowfall
B. Direction and speed of wind during and immediately after a storm
C. Topography

Avalanches are more frequent in regions of heavy snowfall than they are in areas of light snowfall. The amount of new snow available to slide or to become bonded to old snow is influenced also by the frequency of storms: snow may arrive in a few intense storms or it might be spread more thinly in frequent storms. Snow on the ground is layered and has structural properties determined by meteorological conditions prevalent at the time it was deposited and also by changes in response to temperature and pressure.

Winds during and after a storm deposit and redeposit snow in response to topography (see Figure 2-33).

Areas of accumulation (lee slopes, bowls, gullies and openings in the forest canopy) occur where wind speed drops. These areas may be identified on aerial photographs taken in the spring or early summer by the presence of residual drifts except where modified by melt in response to aspect.

In the absence of detailed weather data for mountain ridge tops, refer to 'Snow Survey Measurements Summary 1935-1980' and to 'Canadian Climate Normals 1951-1980 Temperature and Precipitation British Columbia'2.


Figure 2-33\textsuperscript{1} Snow erosion from acceleration zones and redeposition in deceleration zones

\textsuperscript{1}National Avalanche School. 1975. U.S.D.A. Forest Service
DESCRIPTION OF AVALANCHE TRACKS

Avalanche tracks are divided into three zones: starting zone, track, and runout zone (see Figure 2-34).

A. Starting Zone

This is the area in which snow accumulates and structural failure of the snowpack occurs. The critical features of the starting zone are:

1. Aspect

   Aspect determines the wind conditions for the accumulation of snow and the heat budget (incoming radiation) that affect changes and stability in the snowpack.
2. Configuration and terrain irregularity

The configuration of the starting zone determines how much area is potentially contributory to the avalanche. Irregularities, such as unevenness of slope, rocks, trees and other obstructions, tend to hold snow on a slope. Average mountain terrain requires about 60 cm of snow before it will slide. Smooth slopes (ice, grass, soil) may only require as little as 15 cm. The best protection against snow movement is forest cover in the starting zone.

3. Slope angle

The angle of the starting zone appears to be the most important factor influencing the frequency of avalanches. Slopes of low angle (less than 25 degrees) are generally stable because, although structural failure may occur, the snowpack often does not move because of frictional resistance. Steep slopes (45 to 50 degrees) generally do not accumulate enough snow to create a hazard except in maritime climates. Thus, the critical angle of the starting zone lies between 25 and 45 degrees (see Figure 2-35 for bed surface inclination of 100 slab avalanches in the United States, Switzerland and Japan). Open slopes produce large slides less frequently than do gulley-type zones under similar conditions.

B. Tracks

Avalanche tracks may be fed by more than one starting zone. The shape of the track both in cross section and longitudinally influences avalanche behaviour. Slides running in V-or-U-shaped tracks (channelled) move faster than those running on open slopes of similar angle. A bend in a channelled track will have an additional hazard area where the slide may occasionally leave its bed (see Figure 2-36). Rolls or stops in the longitudinal profile will cause an avalanche to dissipate energy before reaching the valley. In Figure 2-36, an avalanche in track A can undercut track B thereby initiating another avalanche in track B.
Appendix 2-4 cont.

![Graph showing the number of slab avalanches versus bed surface inclinations.]

Figure 2-35 Bed surface inclinations

Hazard area

Figure 2-36 Avalanche tracks

C. Runout zone

This is the area of low slope angle where the avalanche loses its energy and stops. The area covered by the runout depends upon the amount and type of snow and the effectiveness of obstacles in creating
APPENDIX 2-4 cont.

drag. If an entire starting accumulation zone releases during a heavy snow year, a slide may overrun previous limits. Also, fire or timber cutting may make more snow available to an avalanche and extend the runout zone.

Runout zones with no obstacles (frozen lakes, meadows) allow snow to spread further but show little evidence of the extent, while a zone in a narrow valley may extend up the opposite slope. An airblast zone may extend beyond the snow limit. In the Rogers Pass area, it was found that avalanches begin to slow down when they reach slopes less than 28 degrees (54 percent).

IDENTIFICATION OF AVALANCHE TRACKS

Large, regularly occurring slides are easily identified because of the disturbance to vegetation. Areas over which large avalanches return infrequently may require an analysis of vegetation for differences in age or species to predict the frequency and extent of avalanches (see Table 2-16). For smaller potential slide areas, carefully consider:

- Slope angle
- Local snow climate
- Evidence of slides on similar slopes in the area
- Density of tree cover
- Tendency of snow to move as indicated by these on-site indicators: deformed tree boles and broken branches

Comparison of air photographs taken several years apart will reveal if a slide is running further downslope. The reason for downslope movement might be heavy snow, fire, or logging in the starting zone. Also, disturbance to re-established tree cover may indicate the frequency of some avalanches (see Figure 2-37).
**APPENDIX 2-4 cont.**

**Table 2-16**

Vegetation as a rough indicator of avalanche frequency

<table>
<thead>
<tr>
<th>Frequency: at least one avalanche in an interval of:</th>
<th>Vegetation Clues</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 2 years</td>
<td>Bare soil, willow, alder and other shrubs, no trees higher than one to two metres. Some broken larger trees.</td>
</tr>
<tr>
<td>2 to 10 years</td>
<td>Few trees higher than one to two metres. Broken and aligned trees up to about three metres long. Damaged tree branches and bark.</td>
</tr>
<tr>
<td>10 to 25 years</td>
<td>Trees 3 to 20 years of age plus secondary species larger but younger.</td>
</tr>
<tr>
<td>25 to 100 years</td>
<td>Trees approaching maturity; the dominant trees are older and larger than those found on more frequent avalanche paths in the same locality.</td>
</tr>
</tbody>
</table>

Note: The vegetative clues vary from one climatic zone to another and they may vary from one soil type to another within the same climatic zone.

Figure 2-37 Changes in age and species composition
APPENDIX 2-4 cont.

AVISCHE PREDICTION

Once potential avalanche sites have been identified, the prediction of how far and how often avalanches will run is difficult. For land-use planning, an indication of the furthest extent and general frequency may be all the information required. Because the amount of snowfall and the forest cover in the start-catchment zone changes, a generous estimate of distance and area should be made, particularly if anticipated land uses include permanent structures or human activity during the winter season. Prediction by terrain analysis (vertical drop, track roughness, and friction coefficient) is possible but complex because predictions of the type of snow and the amount that will release cannot be made accurately without continuous sampling in the start zones.

REFERENCES


WATERSHED MANAGEMENT OBJECTIVES

The objectives of watershed management where water is the priority, are:

A. To maintain the hydrologic balance amongst soil, water and vegetation for optimum functioning of the watershed.

B. To promote favourable conditions of streamflow, including both the seasonal distribution of flow and reduction of flood discharge.

C. To maintain and improve total water yield.

D. To reduce to a minimum, stream turbidity and sediment content.

E. To curtail to the lowest practical level bacterial, biocidal, chemical and other forms of contamination.

GUIDELINES FOR FORESTRY AND FOR CONSTRUCTION AND ROADS

A. Forestry

The impact of forestry on a watershed results from road construction, timber extraction and reduced vegetation cover. Pest and vegetation controls and prescribed burning, if improperly handled, can also markedly effect water quality.

Roads

The guidelines on road construction, operation camps and equipment in Section B must all be applied. In addition to the guidelines for logging roads, two extra considerations are presented:

1. In the interests of stream protection, it may be desirable to compromise on road standards. Roads which tend to follow the "ups and downs" of the natural ground create less disturbance to the natural terrain than do higher grade roads cut to even gradients.

2. Spur roads for extracting logs from the cutting area should attempt to follow the natural ground contours. Upon completion of the logging operations in a specific area, all spur roads should be graded, where practical, to conform with the landscape contours and they should be seeded, or covered with mulch, in areas where significant erosion could develop.

Logging

Watersheds should be harvested in sequential phases to maintain and protect water quality and yield. A cutting plan for the entire watershed should be prepared in advance. The size and location of specific cutting areas should consider the topography, snow conditions, runoff features and any other pertinent aspects of the site as covered in these Guidelines and Appendices.

Denuded areas covering a large percentage of a watershed are contrary to the concepts of good watershed management and should not be allowed. The removal of timber needed to minimize avalanches must be prevented.

Methods of extracting the timber must take cognizance of the natural terrain and the season. Skidding of logs over the ground, except when frozen, should be avoided where the ground slopes are in excess of 15 percent and/or where the soil is readily erodible. Where serious erosion is likely to occur, special extraction techniques using "high cables" and other overhead methods should be used. In certain areas, winter logging on frozen or snow-covered ground may be the only means of extracting timber without causing ground damage.

Skid trails should never be located where they are likely to become auxiliary stream channels in wet weather. Abandoned skid trails should have water-bars cut to prevent erosion and should be seeded immediately upon abandonment.

No logs may be hauled through stream beds. Landing areas shall be located where direct runoff from the landing does not directly enter a stream.

Buffer strips of vegetation at least nine metres wide should be maintained along stream banks. When cutting timber near streams, trees should be felled uphill, away from the channel. Resulting debris should be kept out of the watercourse.

Only selective logging should be allowed (or no logging at all) on certain fragile sites where re-establishment of the species may be in question. Certain steep banks, where the soil has been maintained over the years by the vegetation cover, should also be considered as "no logging areas" or for selective removal of mature trees only.

Pest and Vegetation Controls

Where pests or vegetation are to be controlled by the use of chemicals in any form, either solid or spray, rates of dosages and methods of application must conform at all times to regulations. Because conventional water treatment plants have little effect on pesticides, it is imperative that the use of them within a watershed be rigidly regulated. All programs using pesticides for control of pests and/or vegetation must be submitted to the Pesticide Control Branch of the Ministry of Environment for approval and for a permit.
APPENDIX 2-5 cont.

Prescribed Burning

Prescribed burning within 20 metres of a stream is prohibited, unless special permission is granted by the Regional Protection Officer of the Ministry of Forests and the Regional Manager of the Water Management Branch.

B. Construction and Roads

Many problems in construction have arisen as a result of attempted shortcuts in the interests of cost. Any saving incurred is often at the expense of water quality. All construction should take into account climatological conditions. Work having a major impact on the terrain should be scheduled during periods of expected dry weather. Earth-moving equipment should not be allowed to operate in unduly wet conditions.

Location

Roads should be located on natural benches away from drainage channels and should be graded to minimize disturbance of the natural terrain, rather than to optimize the gradient.

No road should pass through stream beds.

Stream crossings should be carefully selected to minimize interference with banks and channels.

Road Bed Construction

Rough grading should be restricted to what can be properly completed within the chosen work season.

Adequate drains should be provided as work proceeds. On sidehills and near streams, road drains should discharge where sediment can settle out before reaching streams.

Excess soil should not be deposited in or on stream banks; it should be end-hauled to a safe location.

Excessive cuts in easily erodible soils should be avoided.

Fill material which is susceptible to erosion by rain or water should be avoided.

All unstable cut and fill areas should be provided with rip-rap or retaining walls where needed to prevent siltation of streams from erosion.
Drains, Culverts and Bridges

Cross drains, equivalent to a culvert diameter of 45 cm should be placed at all drainage channels and gulleys. An energy dissipater shall be placed at the downstream end of all drains and a ditch block placed on the upstream end on continuous grades. Muddy or silt laden waters should be discharged onto the forest floor or directed towards ponding areas to allow sediments to be removed before water reaches natural streams. Road culverts or cross drains should be placed on natural ground grade with minimum disturbance of natural conditions. Rip-rap or other methods should be used to protect areas where significant erosion is probable. Ends of culverts should extend well beyond the edge of fill. Culverts should not end with a cascade. Energy dissipators should be placed below culverts where velocities are likely to cause erosion.

The design calculations of all stream crossings shall be submitted to the Regional Manager of the Water Management Branch for approval pursuant to the Water Act.

Bridges used for permanent roads, including abutments, should be constructed clear of the highwater mark. Where this is not practical, an approval under the Water Act to construct within the stream channel must be obtained. Temporary seasonal bridges may be exempted.

Earth-covered bridges are prohibited.

It is particularly important that a maintenance program be carried out to ensure that culverts and drains are kept free of debris. Where roads will not be maintained, or abandoned, the natural drainage system must be restored.

Operation Camps and Equipment

Where practical, all construction camps, site offices, equipment storage and servicing areas shall be kept outside watersheds. Where this is not practical, special provisions must be made to prevent oil losses from all machinery or equipment within watersheds. Fuel storage areas must be surrounded by impervious dykes; fueling hoses must have automatic shut-off valves; and all waste petroleum products must be removed from the watershed. All sanitary arrangements for workers must comply with the Health Act or with the Pollution Control Act, 1967.
E.S.A. assessment forms (F.S. 804) are used for both E.S.A. air calls and E.S.A. ground calls. They are a record giving the reasons why an area is or is not given an E.S.A. designation. Complete a form for every E.S.A. air call and E.S.A. ground call and record details on all pertinent E.S.A. categories.
# APPENDIX 2-6 cont.

## E.S.A. ASSESSMENT FORM

<table>
<thead>
<tr>
<th>Project No.:</th>
<th>Assessment No.:</th>
<th>Classifier:</th>
</tr>
</thead>
<tbody>
<tr>
<td>36</td>
<td>25</td>
<td>52</td>
</tr>
</tbody>
</table>

### Province of British Columbia

**Ministry of Forests**

**E.S.A. ASSESSMENT FORM**

<table>
<thead>
<tr>
<th>Region:</th>
<th>Comp:</th>
<th>Drainage:</th>
<th>Elevation:</th>
<th>Date:</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>7</td>
<td>2</td>
<td>19</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B.C.G.S. Mapsheet:</th>
<th>Subdrainage Etc.:</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Polygon No.(s):</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
</tr>
</tbody>
</table>

**Flight Plan Photo No.:** 12

**Classification Photo No.:** 14

**Area of Assessment (Avg. width x length):** 15

<table>
<thead>
<tr>
<th>Soil Moisture:</th>
<th>Wind &amp; Water Erosion:</th>
</tr>
</thead>
<tbody>
<tr>
<td>26</td>
<td>27</td>
</tr>
</tbody>
</table>

**Soil Texture:** 31

<table>
<thead>
<tr>
<th>Landform/Landform Feature:</th>
</tr>
</thead>
<tbody>
<tr>
<td>32</td>
</tr>
</tbody>
</table>

**Rock Outcrop:** 30

### Slope Position

<table>
<thead>
<tr>
<th>% Slope</th>
<th>% Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-20</td>
<td></td>
</tr>
<tr>
<td>21-40</td>
<td></td>
</tr>
<tr>
<td>41-60</td>
<td></td>
</tr>
<tr>
<td>61-70</td>
<td></td>
</tr>
</tbody>
</table>

### Surface Material

<table>
<thead>
<tr>
<th>Material</th>
<th>24</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultural</td>
<td></td>
</tr>
<tr>
<td>Lacustrine</td>
<td></td>
</tr>
<tr>
<td>Till</td>
<td></td>
</tr>
<tr>
<td>Glacial</td>
<td></td>
</tr>
<tr>
<td>Rock</td>
<td></td>
</tr>
</tbody>
</table>

### Soil Material

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>25</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-20</td>
<td></td>
</tr>
<tr>
<td>21-40</td>
<td></td>
</tr>
<tr>
<td>41-60</td>
<td></td>
</tr>
<tr>
<td>61-70</td>
<td></td>
</tr>
</tbody>
</table>

### Wind & Water Erosion

<table>
<thead>
<tr>
<th>Erosion</th>
<th>27</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry</td>
<td></td>
</tr>
<tr>
<td>Deflation</td>
<td></td>
</tr>
<tr>
<td>Moist</td>
<td></td>
</tr>
<tr>
<td>Surface Erosion</td>
<td></td>
</tr>
<tr>
<td>Wet</td>
<td></td>
</tr>
<tr>
<td>Natural Processes</td>
<td></td>
</tr>
</tbody>
</table>

### Forest Type(s)

<table>
<thead>
<tr>
<th>% Area</th>
<th>35</th>
</tr>
</thead>
<tbody>
<tr>
<td>36</td>
<td></td>
</tr>
</tbody>
</table>

### Values Protected

<table>
<thead>
<tr>
<th>Sighted</th>
<th>Critical Habitat Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>46</td>
</tr>
</tbody>
</table>

### Critical Habitat Description

<table>
<thead>
<tr>
<th>50</th>
</tr>
</thead>
</table>

### Browse Survey

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>49</td>
<td></td>
</tr>
</tbody>
</table>

### Species

<table>
<thead>
<tr>
<th>Species</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>46</td>
<td></td>
</tr>
</tbody>
</table>

### Additional Remarks

<table>
<thead>
<tr>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>51</td>
</tr>
</tbody>
</table>

### Details of Forest Type(s)

<table>
<thead>
<tr>
<th>Layer</th>
<th>Species Comp. (10%)</th>
<th>Age (yr)</th>
<th>Height (m)</th>
<th>Special Site</th>
<th>CC (10%)</th>
<th>History</th>
</tr>
</thead>
</table>

**Species:** 45

**Browse Survey:** Yes, No

**Species Survey:** Yes, No

**Critical Habitat Description:** 50

<table>
<thead>
<tr>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>51</td>
</tr>
</tbody>
</table>
APPENDIX 2-6 cont.

INSTRUCTIONS FOR FILLING IN THE E.S.A. ASSESSMENT FORM (F.S. 804)

Complete each section of form F.S. 804 as follows:

<table>
<thead>
<tr>
<th>Slanted Number on E.S.A. Form</th>
<th>Description and Instruction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Enter the name of the T.S.A.</td>
</tr>
<tr>
<td>2</td>
<td>Enter the name of the P.S.Y.U.</td>
</tr>
<tr>
<td>3</td>
<td>Enter the project number.</td>
</tr>
<tr>
<td>4</td>
<td>Enter the assessment number:</td>
</tr>
<tr>
<td></td>
<td>- For air assessments, number as: xEl-1, xEl-2, xEl-3, etc.</td>
</tr>
<tr>
<td></td>
<td>- For ground assessments, number as: xGE-1, xGE-2, xGE-3, etc.</td>
</tr>
<tr>
<td>5</td>
<td>Enter the inventory region number.</td>
</tr>
<tr>
<td>6</td>
<td>Enter the inventory compartment number.</td>
</tr>
<tr>
<td>7</td>
<td>Record the name of the watercourse as shown on a topographic map of the area.</td>
</tr>
<tr>
<td>8</td>
<td>Detail the location of the assessment area, for example:</td>
</tr>
<tr>
<td></td>
<td>- Unnamed creek at 1.0 km west of Tamihi, B.C.</td>
</tr>
<tr>
<td></td>
<td>- 0.7 to 1.3 km on Tamihi Creek</td>
</tr>
<tr>
<td></td>
<td>- Upper third of Tamihi Creek</td>
</tr>
<tr>
<td></td>
<td>- Lower right quadrant of photo B.C. 7806:038</td>
</tr>
<tr>
<td>9</td>
<td>Enter the elevation in metres of a specific point or an elevation range within the assessment area.</td>
</tr>
<tr>
<td>10</td>
<td>Enter the B.C.G.S. map sheet number.</td>
</tr>
<tr>
<td>11</td>
<td>Enter the polygon number(s) in which E.S.A. assessment is done.</td>
</tr>
<tr>
<td>12</td>
<td>Enter the number of the flight plan air photo when an E.S.A. assessment is done from the air.</td>
</tr>
<tr>
<td>Slanted Number on E.S.A. Form</td>
<td>Description and Instruction</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>13</td>
<td>Record the scale of E.S.A. flight plan air photo.</td>
</tr>
<tr>
<td>14</td>
<td>Enter the number of the air photo used for typing the assessment area. Document the E.S.A. assessment on this photo.</td>
</tr>
<tr>
<td>15</td>
<td>The area of assessment refers to the size of the area being assessed. When an E.S.A. is not designated, locate the &quot;xE&quot; or &quot;xGE&quot; at the centre of the area assessed. Make the assessment on a representative portion of the E.S.A. area and extrapolate this information to the remaining area.</td>
</tr>
<tr>
<td>16</td>
<td>Check (✓) if a 35 mm photo was taken.</td>
</tr>
<tr>
<td>17</td>
<td>Use this space to document the classifier's 35 mm photo code, when applicable.</td>
</tr>
<tr>
<td>18</td>
<td>Record the name of the classifier.</td>
</tr>
<tr>
<td>19</td>
<td>Enter the date of assessment.</td>
</tr>
<tr>
<td>20</td>
<td>Enter 'ground', 'air' or 'water'.</td>
</tr>
<tr>
<td>21</td>
<td>Record the E.S.A. category or categories assigned, for example, E51, E51p1 Ep2w2. If an area does not warrant an E.S.A. designation write nil.</td>
</tr>
<tr>
<td>22</td>
<td>Enter the percentage of the assessment area covered by each slope category and enter a representative, measured slope.</td>
</tr>
<tr>
<td>23</td>
<td>Check (✓) the position(s) on the slope.</td>
</tr>
<tr>
<td>24</td>
<td>Check (✓) the surficial material, see 'Terrain Classification System - Revision'.</td>
</tr>
</tbody>
</table>
APPENDIX 2-6 cont.

<table>
<thead>
<tr>
<th>Slanted Number on E.S.A. Form</th>
<th>Description and Instruction</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>Check (√) the soil depth.</td>
</tr>
<tr>
<td>26</td>
<td>Check (√) the soil moisture which refers to the normal water content of the soil.</td>
</tr>
<tr>
<td>27</td>
<td>Check (√) the wind or water erosion process (see Section 2.311).</td>
</tr>
<tr>
<td>28</td>
<td>Check (√) the mass movement process (see Section 2.311).</td>
</tr>
<tr>
<td>29</td>
<td>Enter the number of mass movement indicators per kilometre.</td>
</tr>
<tr>
<td>30</td>
<td>Estimate the percent rock outcrop on the assessment area.</td>
</tr>
<tr>
<td>31</td>
<td>Describe the texture of the surficial material (see 'Terrain Classification System - Revision').</td>
</tr>
<tr>
<td>32</td>
<td>Describe the landform or landform feature (see 'Terrain Classification System - Revision').</td>
</tr>
<tr>
<td>33</td>
<td>Check (√) Es₁ or Es₂ and support the decision in the remarks section (34).</td>
</tr>
<tr>
<td>34</td>
<td>Remarks: use this section to describe the erosional process(es).</td>
</tr>
<tr>
<td>35</td>
<td>List the main forest type(s) within the assessment area.</td>
</tr>
<tr>
<td>36</td>
<td>Estimate the percentage of the assessment area covered by each forest type listed in (35).</td>
</tr>
<tr>
<td>37</td>
<td>Check (√) Ep₁ or Ep₂, and support this decision in the remarks section (38).</td>
</tr>
<tr>
<td>38</td>
<td>Make remarks about the geoclimatic and biotic factors affecting forest regeneration (see Section 2.41) and about forest regeneration, stocking and stand vigour.</td>
</tr>
<tr>
<td>39</td>
<td>Indicate the values to be protected, such as highway, buildings, or high value timber.</td>
</tr>
<tr>
<td>40</td>
<td>Check (√) Eh₁ or Eh₂.</td>
</tr>
</tbody>
</table>
APPENDIX 2-6 cont.

<table>
<thead>
<tr>
<th>Slanted Number on E.S.A. Form</th>
<th>Description and Instruction</th>
</tr>
</thead>
<tbody>
<tr>
<td>41</td>
<td>Record the name and category of the community watershed, or the name of the licensed or non-licensed stream requiring protection.</td>
</tr>
<tr>
<td>42</td>
<td>Check (√) the recreational features. Guidelines for determining recreational and landscape values are given in Section 2.61.</td>
</tr>
<tr>
<td>43</td>
<td>Check (√) Er₁ or Er₂, and support the decision in the remarks section (44).</td>
</tr>
<tr>
<td>44</td>
<td>Describe the recreational feature(s) or landscape feature indicated in (42) and their location on the ground.</td>
</tr>
<tr>
<td>45</td>
<td>List the wildlife species to be protected.</td>
</tr>
<tr>
<td>46</td>
<td>Check (√) when species are sighted and give numbers.</td>
</tr>
<tr>
<td>47</td>
<td>Check (√) when species are not sighted but list indicators of their presence such as browsing and pellets.</td>
</tr>
<tr>
<td>48</td>
<td>Check (√) Ew₁ or Ew₂.</td>
</tr>
<tr>
<td>49</td>
<td>Check (√) if a browse survey was completed on the assessment area.</td>
</tr>
<tr>
<td>50</td>
<td>Describe the critical habitat, for example: &quot;semi-open aspen stand surrounding lowland willow areas, southern aspect, spring calving area&quot;.</td>
</tr>
<tr>
<td>51</td>
<td>Use this section to describe in detail the forest type(s) on the area being assessed for E.S.A.s.</td>
</tr>
<tr>
<td>52</td>
<td>Use this space for any additional comments; for example, fisheries values and stream sensitivities.</td>
</tr>
</tbody>
</table>

EXAMPLE: E.S.A. GROUND CALL

Province of British Columbia  Ministry of Forests  

E.S.A. ASSESSMENT FORM

T.S.A.:  MACKENZIE  PS.Y.:  FINLAY
REGION:  69  COMP:  S1
DRAINAGE:  MUSANA CREEK  ELEVATION:  730 m
B.C.G.S. MAPSHEET:  93D045  SUBDRAINAGE ETC.:  05 KM EAST OF WILLOWTON LAKE
POLYGON NO(S):  101, 103

FLIGHT PLAN PHOTO:  No.  CLASSIFICATION PHOTO:  7329-228

AREA OF ASSESSMENT (Avg. Width x Length):  100 m x 1000 m  PHOTO:  Yes  No  ROLL 2 PHOTO #14

<table>
<thead>
<tr>
<th>% SLOPE</th>
<th>% AREA</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-20</td>
<td>21-40</td>
</tr>
<tr>
<td>41-60</td>
<td>61-70</td>
</tr>
<tr>
<td>71+</td>
<td>MEASURED 65%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SURFICIAL MATERIAL</th>
</tr>
</thead>
</table>
| Upper | Colluvial | E.
| Middle | E. | No.
| Lower | Fluvial | Organic |

<table>
<thead>
<tr>
<th>SOIL DEPTH (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thin 0-50</td>
</tr>
<tr>
<td>Shallow 51-200</td>
</tr>
<tr>
<td>Deep 201+</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WIND &amp; WATER EROSION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry</td>
</tr>
<tr>
<td>Most</td>
</tr>
<tr>
<td>Wet</td>
</tr>
<tr>
<td>Karst Processes</td>
</tr>
<tr>
<td>Piping</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>E.</th>
<th>VALUES PROTECTED:  N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>E.</td>
<td>COMMENTS:  NEGLIGIBLE</td>
</tr>
<tr>
<td>E.</td>
<td>RECREATIONAL VALUES:  SOME SMALL TROUT NEAR CREEK MOUTH</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SPECIES</th>
<th>SIGHTED</th>
<th>YES</th>
<th>NO</th>
<th>CRITICAL HABITAT DESCRIPTION</th>
<th>SUITABLE FOR MOOSE</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>LAYER</th>
<th>SPECIES COMP (10%)</th>
<th>AGE (y)</th>
<th>HEIGHT (m)</th>
<th>SPECIAL SITE</th>
<th>C.C. (10%)</th>
<th>HISTORY</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>5% 6%</th>
<th>10</th>
<th>32</th>
<th>60</th>
</tr>
</thead>
<tbody>
<tr>
<td>8% 8%</td>
<td>180</td>
<td>24.0</td>
<td>60</td>
</tr>
</tbody>
</table>

ADDITIONAL REMARKS:  

FS 0494N 8405  

127
APPENDIX 2-6 cont.

EXAMPLE: E.S.A. AIR CALL

![Image of E.S.A. Assessment Form]

**Province of British Columbia**

**Ministry of Forests**

**E.S.A. ASSESSMENT FORM**

**T.S.A:** LAKES

**PS.Y.U.:** 007SA

**PROJECT NO.:** 165

**ASSESSMENT NO.:** E7-13

**CLASSIFIER:** JIM DICK

**CLASSIFICATION PHOTO NO.:** SAME

**METHOD:** AIR

**DATE:** 04-07-16

**E.S.A. DESIGNATION:** E72

**REGION:** 6

**COMP.:** 113

**DRAINAGE:** SAM HARDING Ck.

**ELEVATION:** 700 m

**0.5 km SECTOR ALONG CREEK**

**BELOW THE LAKE.**

**FLIGHT PLAN PHOTO NO.:** 7736-180

**SCALE:** 1/15,840

**CLASSIFICATION PHOTO NO.:** SAME

**AREA OF ASSESSMENT (avg. width x length):** 200 m x 500 m

**35mm PHOTO:** Yes

**ROLL & PHOTO #:** 21

**SOIL MOISTURE:**
- Dry
- Deterioration
- Surface Erosion
- Surface Erosion
- Karst Processes
- Piping

**SOIL EROSION:**
- Gently
- Moderately
- Severe

**SOIL MATERIAL:**
- Cohesive
- Organic
- Rock

**SOIL DEPTH (cm):**
- Thin 0-50
- Shallow 51-200
- Deep 201+

**Slope Position:**
- Flat
- Glacial
- Eroded

**Slope Area:**
- 0-20
- 21-40
- 41-60
- 61-70
- 71+
- Measured

**% ROCK OUTCROP:**
- 0%

**SLOPE TEXTURE:**
- Sandy
- Clayey
- Loamy

**LANDFORM/LANDFORM FEATURE:**
- Sloping, well-drained
- Glacial till

**FOREST TYPE(S):**
- Recreational Site
- Waterfall/rapids
- Topographic feature
- Wildlife viewing
- Hunting

**VALUES PROTECTED:**
- Popular fishing area, good camping area, well-drained site, fresh water supply, attractive area accessible by 4-wheel drive

**SPECIES SIGHTED:**
- Moose

**BROWSE SURVEY:**
- Yes

**CRITICAL HABITAT DESCRIPTION:**
- Only minimal browse species were sited in the assessment area.

**DETAILS OF FOREST TYPE(S):**

<table>
<thead>
<tr>
<th>Layer</th>
<th>Species Comp (10%)</th>
<th>Age (y)</th>
<th>Height (m)</th>
<th>Special Site</th>
<th>CC (10%)</th>
<th>History</th>
</tr>
</thead>
</table>

**ADDITIONAL REMARKS:**
## APPENDIX 2-7

### YEAR OF CLASSIFICATION FOR ENVIRONMENTAL SENSITIVITY BY UNIT

<table>
<thead>
<tr>
<th>P.S.Y.U. Name</th>
<th>Year</th>
<th>P.S.Y.U. Name</th>
<th>Year</th>
<th>Sub-unit Name</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adams</td>
<td>78</td>
<td>Moberly</td>
<td>78</td>
<td>Ahta River</td>
<td>78</td>
</tr>
<tr>
<td>Alsek</td>
<td>Not done</td>
<td>Monkman</td>
<td>77</td>
<td>East Canoe Creek</td>
<td>78</td>
</tr>
<tr>
<td>Arrowhead</td>
<td>77</td>
<td>Morice</td>
<td>77</td>
<td>McNulty Creek</td>
<td>78</td>
</tr>
<tr>
<td>Asnholna</td>
<td>77 82</td>
<td>Nakusp</td>
<td>74</td>
<td>Mehatl Creek</td>
<td>78</td>
</tr>
<tr>
<td>Baunye</td>
<td>74</td>
<td>Narcosli</td>
<td>74</td>
<td>Nahatlatch Creek</td>
<td>78</td>
</tr>
<tr>
<td>Barriere</td>
<td>78</td>
<td>Naver</td>
<td>78</td>
<td>Pemberton Creek</td>
<td>78</td>
</tr>
<tr>
<td>Barton Hill</td>
<td>77 82</td>
<td>Nechako</td>
<td>75</td>
<td>Potlatch Creek</td>
<td>78</td>
</tr>
<tr>
<td>Bell-Irving</td>
<td>78</td>
<td>Nehallist on</td>
<td>73</td>
<td>Trinity Valley</td>
<td>78</td>
</tr>
<tr>
<td>Big Bar</td>
<td>76</td>
<td>Nicola</td>
<td>77 81 82</td>
<td>Upper Yalakom R.</td>
<td>78</td>
</tr>
<tr>
<td>Big Valley</td>
<td>78 80</td>
<td>Niskonlith</td>
<td>78</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blueberry</td>
<td>78</td>
<td>Nootka</td>
<td>78</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Botanie</td>
<td>77 82</td>
<td>North Thompson</td>
<td>78</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boundary</td>
<td>Not done</td>
<td>Okanagan</td>
<td>75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bowron</td>
<td>78 80</td>
<td>Ootsa</td>
<td>76</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Burns Lake</td>
<td>78</td>
<td>Parsnip</td>
<td>78</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canoe</td>
<td>74</td>
<td>Peace</td>
<td>78 82</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carp</td>
<td>73</td>
<td>Pr. George S.S.A.</td>
<td>78 79</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chilko</td>
<td>78 82</td>
<td>Purden</td>
<td>78</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cottonwood</td>
<td>78 80</td>
<td>Quadra</td>
<td>77 79 80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cranbrook</td>
<td>78 79</td>
<td>Queen Charlotte</td>
<td>77</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Creston</td>
<td>73</td>
<td>Quesnel Lake</td>
<td>78</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crook ed River</td>
<td>73</td>
<td>Raft</td>
<td>78</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dawson Cr. S.S.A.</td>
<td>78</td>
<td>Rivers Inlet</td>
<td>78</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dean</td>
<td>78</td>
<td>Robson</td>
<td>74</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deese</td>
<td>Not done</td>
<td>Salmon Arm</td>
<td>74</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dewoney</td>
<td>74</td>
<td>Salmon Arm</td>
<td>78 78</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eagle</td>
<td>78</td>
<td>Snusswap</td>
<td>75 79</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Egewood</td>
<td>77</td>
<td>Sikanni</td>
<td>78</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fernie</td>
<td>73 79</td>
<td>Similkameen</td>
<td>77 80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Finlay</td>
<td>77</td>
<td>Skeena</td>
<td>76</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fontas</td>
<td>78</td>
<td>Slocan</td>
<td>77</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fort Nelson</td>
<td>78 80</td>
<td>Smithers</td>
<td>76</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ft. St. John S.S.A.</td>
<td>78</td>
<td>Soo</td>
<td>75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Furry Cr. S.S.A.</td>
<td>77</td>
<td>Spallumcheen</td>
<td>77</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grandby</td>
<td>77 79</td>
<td>Stikine</td>
<td>77</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hecate</td>
<td>78 79 80</td>
<td>Stuart Lake</td>
<td>77</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kamloops</td>
<td>77</td>
<td>Stum</td>
<td>78 79 80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kechika</td>
<td>Not done</td>
<td>Takla</td>
<td>77</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kettle</td>
<td>77</td>
<td>Taku</td>
<td>77</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kindbasket</td>
<td>77 81 82</td>
<td>Upper Kootenay</td>
<td>77 79</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kingcome</td>
<td>77 81 82</td>
<td>Vancouver</td>
<td>77</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Klappan</td>
<td>Not done</td>
<td>Wapiti</td>
<td>78</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kluskus</td>
<td>75</td>
<td>Westlake</td>
<td>75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kotcho</td>
<td>78</td>
<td>Williams Lake</td>
<td>73</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lac La Hache</td>
<td>77</td>
<td>Willow River</td>
<td>78</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lardeau</td>
<td>77 80 82</td>
<td>Windermere</td>
<td>74</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liard</td>
<td>78</td>
<td>Yalakom</td>
<td>77</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longworth</td>
<td>77</td>
<td>T.F.L. 1</td>
<td>75</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>T.F.L. 6</td>
<td>80</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>