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Herring Spawn Survey Manual

(Revised January 2013)

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2012 Data Feedback

This is a short list of data collection problems found when the 2012 data was processed. Dive supervisors are requested to review this list and the appropriate sections with their divers before their survey starts. For further information please contact Charles Fort.

1) Chart Marking – Use the following:

   √ Spawn found on transect.
   X Dove, no spawn found, transect outside of EOS.
   0 Dove, no spawn found, transect inside spawn bed. These transects are included in beach length.
   S Transect skipped
   Other symbols – include your own legend.

2) Put raking and spot dive notes on charts. Data sheets do not need to be filled out for these.

3) Include data sheets for zero length transects (bare transects within the spawn bed). Spot dives on transects outside the spawn bed do not need a transect sheet, just a note in the dive log and on the transect chart. 0 length transects must be entered in the data file if they are within the spawn bed (see following note). MarkingCharts

4) Field generated transect numbers must be between 1 and 999. This prevents conflicts with permanent transect numbers in the same statistical area.

5) Please review the section on recording multiple spawns within a location. If there is more than a 700 metre gap (2 bare transects) in the spawn it should be recorded as Spawn 01, Spawn 02, etc. MarkingCharts

6) Please review spawn length recording. If spawn only exists on understory vegetation then total spawn length must equal understory length. Macrocystis is mapped as separate beds with their own spawn (macro) length. The total spawn length depends on how much overlap there is between macrocystis and understory beds. SummaryForm

7) Short transects must still have stations recorded on them. Ignoring "trivial" amounts of spawn can bias the final estimates. StationPlacement

8) Avoid using the same vegetation code (SA, LA) more than once per station. This probably occurs with Egregia (feather boa) and smaller algae in the same quadrat. Egregia should be coded as KF and lumped in with other flat kelp. SpawnOnVegetation

Introduction

British Columbia herring return to many of the same locations to spawn each spring. During the last fifty years Fisheries personnel have surveyed these areas and used the data to assess the success of spawning.

Before 1988 all spawn surveys were surface surveys conducted by beach walking, raking, and viewing vegetation beds from small boats. This method does not properly assess spawns in deep or murky water. It is, however, quite adequate for narrow spawns in shallow water and is still used extensively for surveying minor spawns. Since 1988 SCUBA teams have surveyed all major spawn beds.

The data collected by these surveys is used to estimate the number of fish which returned to spawn. By itself it cannot tell us anything about survival or returns in the years to come, but when combined with catch and test fishery sample data it becomes a critical link in assessing the size and strength of the herring stocks.

This manual provides an overview of methods used to conduct herring spawn surveys, and is the basic reference for herring spawn surveys. It is not a substitute for on-grounds training and experience. For more detailed information on both dive and surface surveys refer to the publications listed in the bibliography. Where this manual differs from previous manuals, follow the instructions given here.

This manual was developed from a series of published and unpublished works from authors including Carl Haegele, A.S. Houston, and R.D. Humphreys of the Pacific Biological Station, as well as Tom Shields and Jane Watson of Archipelago Marine Research.

General Dive Procedures

Please read Appendix A: “Herring Spawn Survey Safe Diving Procedures”, Dives conducted outside of these procedures are a violation of the Terms of Contract, whether or not they might be considered “safe” by other agencies.

Personal Dive Equipment

The diving kit required for the spawn survey is the standard SCUBA kit with a few modifications. Bring a good supply of spare, one extra kit per ship is recommended as it can take several days and several hundred dollars to ship a replacement part to some of the more remote locations on the coast.

When selecting kit keep in mind the weather (variable, but expect cold, with sleet and snow as the worst case), the amount of swimming required (10 to 20 kilometres for each diver during the survey) and the water conditions (7 degrees south, 5 degees in the north). Divers must stay warm and streamlined.

- Dry suit: Knee pads and heavy duty boots are recommended as in some areas the spawn will be in the intertidal zone on very jagged rocks and in sea urchin beds. A convenience zipper is a pleasant luxury. Bring spare dive underwear as leaks are common, whether from urchin spine punctures or herring eggs stuck in exhaust valves. In the Central Coast the transects are often very short and divers do not get a chance to warm up properly either swimming or between dives, so extra insulation is advisable.

- Gloves: Marigold (rubber) gloves with liners, clamped or taped to a sealing ring in the suit’s arms seem to work best. Conventional foamed neoprene gloves wear out very quickly when handling lead line unless the palm and inside of the fingers are treated with Tool-Dip or a similar rubber moulding compound. Without this they will wear through after 3 to 4 days.

- Mask: Tape tag ends of strap if loose. Snorkel may be removed.

- Fins: Tape tag ends of straps, or reverse straps so that the tag ends are inside. This prevents them hanging up in kelp.

- Regulator: Regulators need to be serviced and tested BEFORE the survey. Some seals must “wear in” before final adjustments can be made and shop techs have been known to reassemble regs incorrectly. A record must be kept of the regulator’s maintenance. Remove any unnecessary hoses, and keep consoles and backup second stages secured close to the body.

- Single cylinder back packs must be fitted with a quick release tank band. Trim loose tag ends of harness straps close to buckles.

- Buoyancy Compensation Devices are now required “appropriate to the diving conditions” (24.38). If used, extra care must be taken to secure inflator hoses and loose straps.

- Weight: Divers should be trimmed to be neutral at 3 metres / 10 fsw with 500 p.s.i. / 35 bar of air remaining. This allows the diver to comfortably remain on station near the end of the transect without fighting to stay down with a near empty cylinder. If extra weight is required it can often be placed on the tank or harness or one or two sets of ankle weights can be carried. If you are susceptible to a sore back I recommend either the aluminium weight board developed by Doug Miller at the Biological Station or a stainless steel back plate like those used by technical divers.

- Watch: All divers **must** carry one. Legally each diver must carry a timing device and divers need to record the real time at each station accurately. Cheap ($30 Casio or Timex) diving watches have performed well on the survey. If a watch is not available divers can record the Time In at the top of their data sheets and the elapsed time at each station on the data sheets using a dive timer or computer, converting this later to actual time. Care must be taken not to lose data if this procedure is needed.

- Knives: Knives tend to get lost easily. “Rescue”” type knives are available for $12 - $20 from net shops, fishing gear suppliers and some outdoor adventure shops. Rescue knifes normally have a sheep’s foot profile but some fishing knifes may come with a sharp point. Remove this with a grindstone, especially if you will be working in surf zones.

- Signalling devices: Some means of attracting the tender’s attention (whistle, “safety sausage”” or orange garbage bag, flare, or strobe) are now required and must be carried on open water dives.

Dive Logs

The dive logs used in this survey have been modified to conform to Canada and B.C. Occupational Health and Safety Regulations requirements. In addition to diver safety and record keeping requirements these logs are part of the final data package returned to P.B.S. and are often needed to correct errors in the other data sheets. These logs must be recorded in real time by the boat operator otherwise they lose their value for correcting errors, in addition to violating regulations.

All dives during a spawn survey charter must be logged and accounted for, including after hours sport dives.

Fisheries and Oceans Dive Log

Open-Circuit Compressed Air SCUBA, No Decompression, DCIEM Tables

Last Name | First Name | Diver ID

Date (year/mon/day) _ / _ / _ | Stat. Area | Location

Investigation: ○ Enforcement ○ Groundfish ○ Herring ○ Mechanical ○ Salmon ○ Shellfish ○ Training ○ Other ________

Known Hazards: ○ Current ○ Entanglement ○ Machinery Locked Out ○ Overhead ○ Surf ○ Traffic ○ Visibility ○ Wildlife ○ Other

Underwater Comms: ○ Hand Signals ○ Line ○ Wire ○ Wireless

Surface Comms: ○ VHF ○ Cell ○ Satellite Phone

Dive Type: ○ Basic ○ Specialty ________

Water: ○ Salt ○ Fresh

Suit: ○ Dry ○ Wet

Emergency Procedures Discussed: ○ Yes

Equipment Check: ○ Yes

Reserve Air: ○ 500 psi ○ Pony

Transect	Tank PSI Start	Time Left Surface	Time Left Bottom	Time Arrive Surface	Max. Depth (Feet)	Bottom Time (Min)	Tank PSI Finish
		:	:	:			
			Effect. Bot. Time	Table (ft/min) /			Repet. Group
		:	:	:			
Surf. Interval :	Repet. Factor .		Effect. Bot. Time	Table (ft/min) /			Repet. Group

Dive Team

Supervisor: | Diver (Alt. Supervisor):

Tender: | Diver:

38002

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Dive Supervisor Signature: ____________ Page _ Of _

The lines below ""Investigation"" in the header may be ignored unless a DFO employee is being logged.

The ""Table (ft/min)"" reference following ""Effective Bottom Time"" on the second line of each dive record refers to the table used to calculate the repetitive group. For example, a 47 foot dive for 22 minutes would use the 50 foot / 30 minutes table. This field is optional.

DIVE SURVEY PROTOCOL

Survey Calibration

All depth gauges must be checked for accuracy at the start of the survey. Use a marked shot line in quiet water or compare all depth gauges on one dive and reject any varying from the others by more than two feet. The gauges may be checked at the Pacific Biological Station before the survey through prior arrangement.

All divers must be calibrated as well. During the first twelve transects of the season, the divers will dive as buddy pairs rotating the dive teams and comparing observations at each station. After twelve transects, each diver should have compared observations with each of the other three divers on at least two transects.

Mapping out the Spawn Bed

The first task is to map out the spawn beds. Fisheries overflights and patrols and reports from vessels in the area are the best sources of information on areas of spawning activity. You will need to verify the presence and extent of spawn by raking or making spot dives.

Calculate the total length of spawn. Ideally this is done by measuring the distance between the ends of spawn (EOS) through the middle of the spawning bed following the depth contour running through the middle of the spawn bed. If working from permanent transect charts it is accurate enough to count the number of transects in the spawn bed, subtrate 1, multiply by 350 metres, then estimate the distance between the EOS and last transect on each end of the bed and add this to the total.

Before any transect or macrocystis data sheets are entered, the spawn must be mapped and assigned a location name.

All charts and data sheets become permanent records in the herring spawn database. They must be clearly marked and neatly organized, otherwise we lose a valuable stock assessment and research tool.

Plotting Transects

Permanent transects have been plotted for most the major spawning beds on the coast. (Figure 1).

Permanent transect numbers are four digits, ranging from 1001 to 9999. The first digit is the herring section, and the last three the sequential transect number. To avoid confusion, use 1 – 999 to number new transects plotted in the field.

Record the following on working field charts:

1) Ends of spawn (EOS). Flight observations provide a good place to start looking, but milt can drift considerable distances. Always confirm the edges of a bed by raking or direct observation.

2) Year. Record the year on each chart to avoid confusion if a chart becomes separated from the data package accidentally or a chart with the pervious year's data is accidentally used.

3) Spawn dates. Alternately this can be recorded on the summary sheet but must be recorded somewhere in the data package.

4) Spawn Number. If there is just one spawn bed running continuously through the location (and no waves of spawn at the same location) then Spawn Number will be 01. If there is a break of more than 700 metres (2 transects) then the bed after the gap becomes Spawn # 02. If herring spawn in the same location after the first bed has hatched this will become Spawn #02 as well.

5) Each transect is marked as it is checked for spawn using the symbols below and notes. Avoid abbreviations other than these as they confuse data processors.

√	Spawn found on transect.
X	Dove, no spawn found, transect outside of EOS. The transect is outside the spawn bed or in a gap greater than 700 metres between two spawn beds. It is not necessary to fill in a transect data sheet for these transects.
0	Dove, no spawn found, transect inside spawn bed. Include a data sheet for these transects. Include these transects in beach length.
S	Transect skipped.

Other symbols – include your own legend.

6) A line drawn above the shoreline between the two EOS highlights the spawn when photocopies of the original chart are made.

Figure 2 below shows a correctly marked chart.

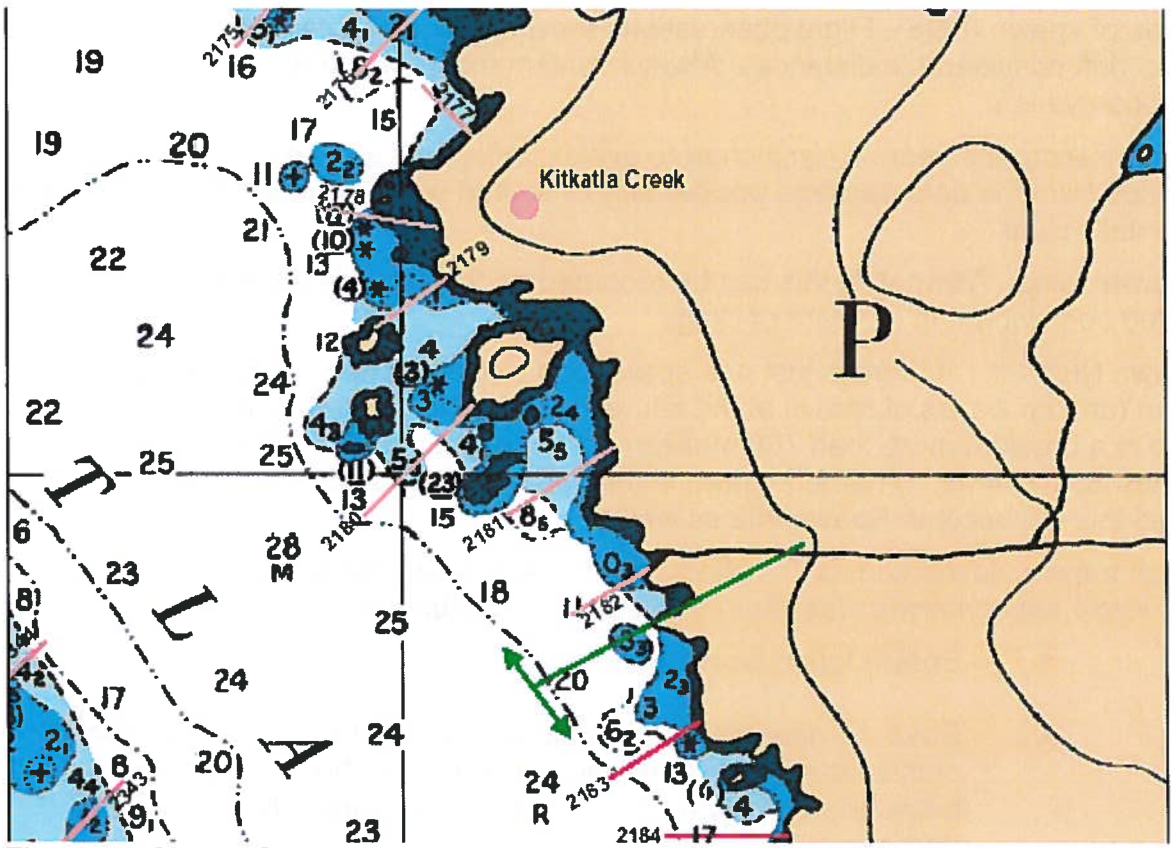


Figure 1 Spawn Survey Transect Chart
Location Name is shown next to a dot with the same colour as the transects in that location. Boundaries between locations are marked with a double headed green arrow.

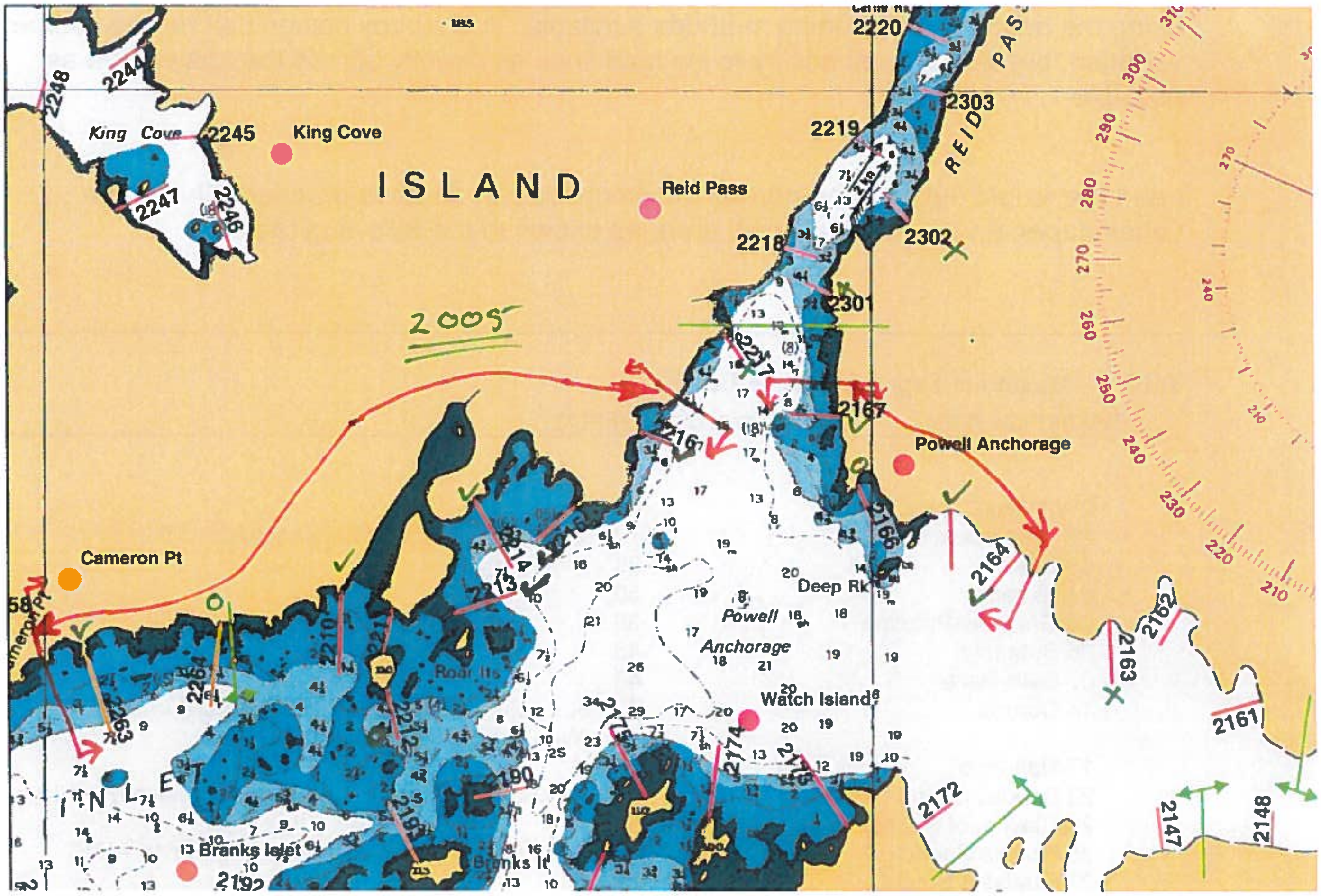


Figure 2 Marked Spawns

Every year some bodies of herring will spawn in locations outside their normal spawn beds at sites where permanent transects aren't plotted. When this happens a set of transects needs to be plotted on a regular hydrographic chart.

Start by laying out the first transect roughly 200 metres in from one EOS. Succeeding transects are plotted **350 metres** apart from this point. Measure along the depth contour (or between two contours) where the centre of the spawn bed is expected to be. The preferred plotting tool is a curvimeter however the digital equivalent isn't available through computer navigation programs.

Field plotted transects must be numbered between 0001 to 0999 so these transects won't conflict with existing permanent transects. Permanent transects are always numbered greater than 1000. The field transect number you assign must be unique within a statistical area.

Once diving begins, the dive team lays out the lead line at the position of the transect using the best dead-reckoning methods available. The survey design can tolerate some variation, but teams must still try to lay lead lines as directly across the spawn bed as possible.

Lead line is laid out until the normal maximum spawn depth is reached. This depth varies depending on the statistical area, as shown in the following table.

Table 1. Maximum Expected Spawn Depths

STATISTICAL AREA	MAX. SPAWN DEPTH (FEET)	
2W West Coast Q.C.I.	60	
2E East Coast Q.C.I.	70	Selwyn Inlet occasionally exceeds 110'.
03 Nass	36	
04 Skeena	50	
05 Grenville-Principe	39	
06 Butedale	48	
07 Bella Bella	43	
14 Comox	42	Since 2002: Cape Lazo: > 60', Qualicum to 60', Whaling Station Bay to 90'.
17 Nanaimo	45	
23 Barkley Sound	60	Newcombe Channel & islands occasionally > 120'.
24 Clayoquot Sound	30	
25 Nootka Sound	36	2006/07: Bed off Flower Islet from 80' to >175'.
27 Quatsino Sound	55	

Small beds less than 1.5 kilometres in length should be sampled with a minimum of three transects.

Time Allocation

In areas where spawn is less than 100m wide a dive team can usually complete two transects an hour. In areas of wide spawns, expect this to decrease to four or less per day.

Weather permitting, the oldest spawn is surveyed first. Spawn takes about 14 days to hatch in the south, and closer to 21 days in the north, depending on water temperature. Spawn in exposed locations should be given priority next, as weather allows. As a last resort, if time does not allow a complete survey skip every other transect, and return to survey the missed transects if time becomes available later. Areas of the heaviest spawn should be given priority during the second pass.

Transect Observations

The two main tools used for sampling herring spawn are the lead line and the quadrat. The lead line is made up of 20 metre sections of light weight lead line marked in metres. The lead line is placed along the slope of the shoreline, so that it runs directly across the spawn bed, then used to measure the spawn bed width and position the quadrat for spawn density observations.

The quadrat is a collapsible square frame made up of two aluminum rods connected by two pieces of cord. When unfolded it encloses one half of a square metre. The quadrat is placed at regular pre-determined locations (stations) along the transect and observations are made of the spawn density found within the quadrat at each station.

Placement of Transect Line

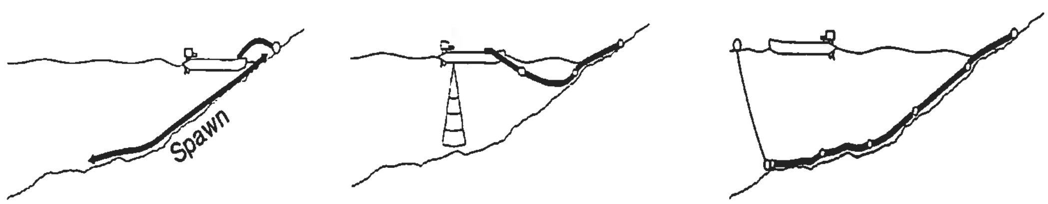


Figure 3 Setting the Leadline (Short Transects)

The open circles in Figure 2 are the shackles connecting each 20 metre section together. A 5 lb. cannonball attached to the beach end of the lead line is thrown so that it lands just above the upper edge of the spawn bed. In some cases, at low tide on mud flats, the cannonball must be walked up the beach to the upper edge of spawn.

The tender skiff moves out from shore, laying the lead line directly across the spawn bed. For long transects (greater than one to two hundred metres) it is often more efficient to take the time to swing the bow of the skiff seaward and lay the transect from the stern. When the depth sounder indicates the maximum expected depth of spawn the lead line is broken and a weighted buoy attached to the end. Table 1 gives the maximum spawn depths for each statistical area.

Number and Spacing of Stations

Once the lead line is set, the divers swim down the buoy line and along the transect until they reach the edge of the spawn bed. At this point, they must calculate the spacing required between stations to sample the transect properly. The spacing will change depending on the width of the spawn bed. **For most transects, a minimum of five quadrats is required.**

Most lead lines are now marked with metre disks at each shackle, and can be used like a tape measure to estimate the width of spawn. To calculate quadrat spacing, divide the estimated spawn width by 5, then round down to the nearest 5 metres. This should give 5 to 6 stations on the transect, and allow divers to work off the 5 metre marks on the lead line, rather than counting individual metre marks.

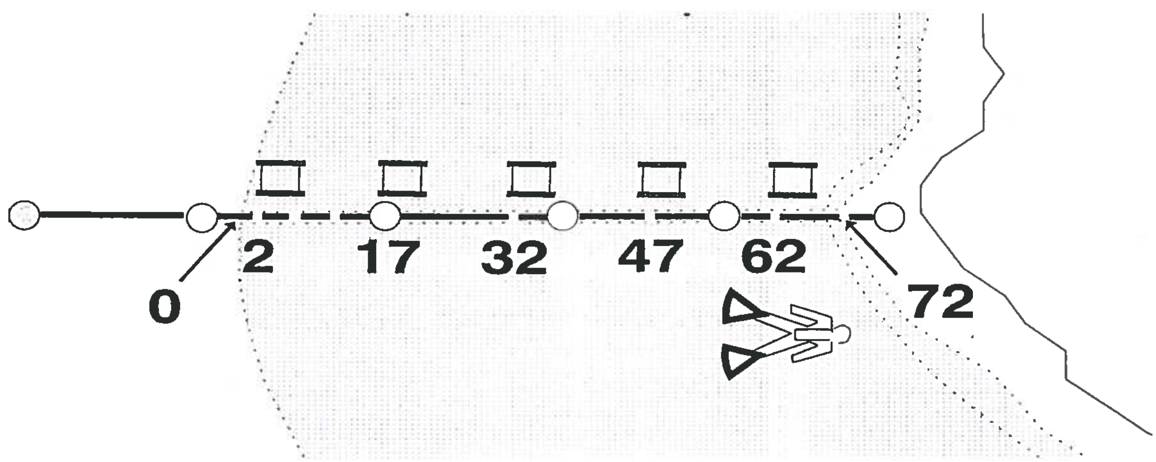


Figure 4 Station Spacing

In Figure 4, the outer edge of the spawn is found near the 80 metre mark. 80 metres divided by 5 stations = 16 metres. Round **down** to the nearest 5, giving a spacing of 15 metres between stations.

The **maximum spacing between stations is 40 metres**. If the bed is 200 metres or more wide, no calculation is necessary, set the spacing at 40 metres. Note that this usually yield more than 5 stations on a transect.

The **minimum spacing is two metres**. A bed 10 metres or less wide will have fewer than five stations spaced 2 metres apart.

DO NOT SKIP NARROW TRANSECTS. THIS WILL BIAS THE DATA.

Note in Figure 4 that the first station is positioned several metres in from the edge of the spawn, falling on a 5 metre mark. There are two reasons for this. The spawn at the edge of the bed is often very patchy, so moving in a few metres puts the first station into a more ""normal"" area of spawn. The second reason is to make it easier for the divers to keep track of where they are along the transect. The 5, 10, and 20 metre marks are fluorescent orange, and much easier to track than counting individual one metre marks.

Quadrat Observations

The header (statistical area, transect, date, diver id, and spawn width) must be filled in completely on each Transect Observations sheet used

Statistical Area must be recorded, otherwise it is possible for Transect numbers (which are repeated across statistical areas) to be mixed up. Subareas are not used in herring research, so there is no need to record them.

Date is recorded as year/month/day, so April 1, 1998 becomes 1998/04/01. Be careful not to reverse month and day.

Diver ID is usually the recording diver's three initials. This is needed to find and correct systematic errors made by individual divers.

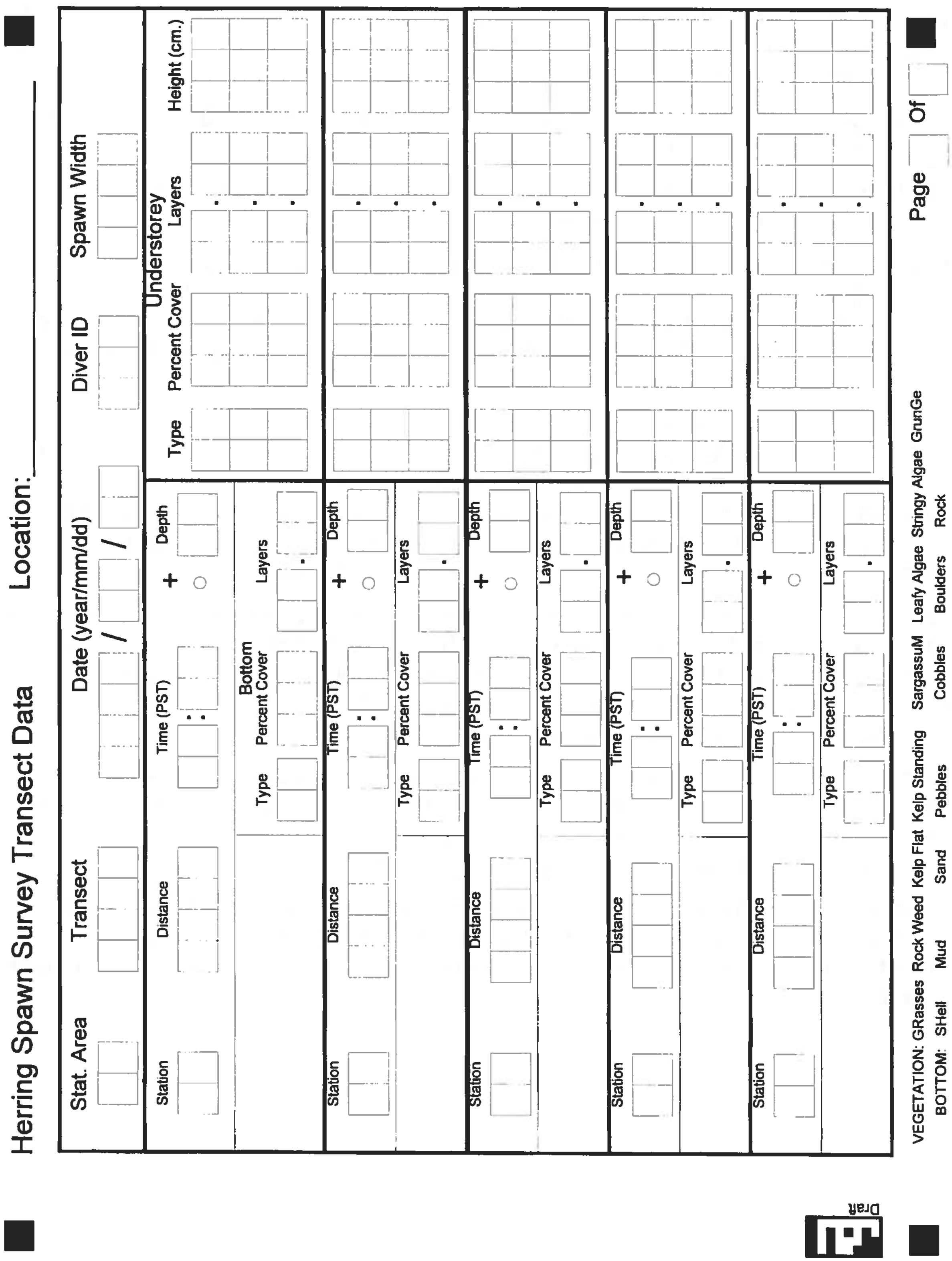
Spawn Width is recorded once the divers have confirmed it by swimming the transect and finding both the outer and inner edges of the bed. If no spawn is found a "0" is entered. 0 length transect sheets should only be kept and entered into the data entry program if the transect falls in a gap in the spawn bed (i.e., less than 700 metres wide).

The first box in each **Station** record must be filled in completely (station, distance, time, and depth). The first station is always the outermost on the transect, the first set when moving shoreward. If a transect has to be "flipped" make sure that notes are made on the sheets indicating how the temporary station numbers need to be changed before the data can be entered. Negative numbers work well as temporary numbers for stations worked to seaward from the buoy on a flipped transect.

As explained above, the **Distance** is the distance from the outer edge of spawn to the current station, in metres, and should only be 0 for very narrow spawns (less than 4 metres wide). If the cannonball lies below the inner edge of spawn (mudflats at low tide), continue measuring distances by running another piece of lead line up to the inner edge of spawn, or pacing the distance off with the metre stick.

Due to our use of North American depth gauges, **Depth** is recorded in feet. If the station is located above water level in the intertidal zone, estimate the height above water level and check the bubble labeled "+". *Do not record stations above water level as "0" (unless they fall directly on the water's edge) or blank.*

Time is always recorded as Pacific Standard Time, otherwise errors occur when the depth is converted to chart datum (to allow for the state of the tide). Be careful of the change to Daylight Savings time in April, do not set the recording watches ahead one hour at this time.


Herring Spawn Survey Transect Data

Location:

Stat. Area | Transect | Date (year/mm/dd) / / | Diver ID | Spawn Width

Station | Distance | Time (PST) : | + ○ Depth

Bottom: Type | Percent Cover | Layers .

Understorey: Type | Percent Cover | Layers . . . | Height (cm.)

VEGETATION: GRasses Rock Weed Kelp Flat Kelp Standing SargassuM Leafy Algae Stringy Algae GrunGe

BOTTOM: SHell Mud Sand Pebbles Cobbles Boulders Rock

Page Of

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Figure 5 Transect Data Form

Bottom Spawn

Bottom spawn is spawn deposited directly on rocks, shells, or other bottom types (see below). Spawn on algae less than 1 cm high is also classed as bottom spawn.

The Bottom and Understorey fields on the transect form have been changed from previous versions. observations are covered in more detail below. Briefly, Bottom Type is always recorded, either as the dominate bottom type with spawn on it, or the dominate bottom type where not spawn is present. **Percent Cover and Layers are left blank if spawn is absent. Do not enter zeros.** The Layers field now has a fixed decimal point, as we've had problems with missing decimal points in the past. Two layers would be entered as 2.0, a quarter layer as 0.25, trace as 0.01.

Bottom Type

Bottom type is always recorded, whether or not spawn is present. The bottom type is the dominant or most heavily spawned on type. If no spawn is present, Cover and Layers is left blank.

Bottom Type	Symbol	Description
Shell	SH	Broken clam shells
Mud	M	Doesn"t settle when stirred up
Sand	S	Individual grains visible
Pebbles	P	Up to the size of an egg. Can be picked up with thumb & forefinger.
Cobbles	C	Egg size to size of a person"s head (25 cm. in diameter) Can be picked up with one hand.
Boulders	B	Need two hands or heavy machinery to pick up.
Rock	R	Outcroppings of bedrock.

Percent with Eggs

This is the percent of the quadrat which is covered with bottom spawn. In Figure 5 a boulder occupies most of the quadrat. Cover ranges from 5 to 100, in 5% increments.

Egg Layers

A layer of eggs one egg thick over the entire spawned surface is recorded as one layer. An additional layer over half of the spawned surface is 0.5 layers. See Figure 6. Decimal points are difficult to see when written in pencil, so the transect form is printed with a fixed decimal point. One layer must be recorded as 1.0, with the "1" to the left of the decimal point. Writing "1" in the first box will result in the data being keypunched as 0.01 layers, or trace. To avoid confusion for the person keypunching the data record trace spawn as "0.01" with the leading zeros written.

If only a trace of spawn is present (a few scattered eggs or less than 5% cover) then 0.01 is entered for layers. In all cases, except for traces of spawn (0.01 layers), egg layers are recorded in 0.25 layer increments (i.e. 0.25, 0.50, 0.75, ...)

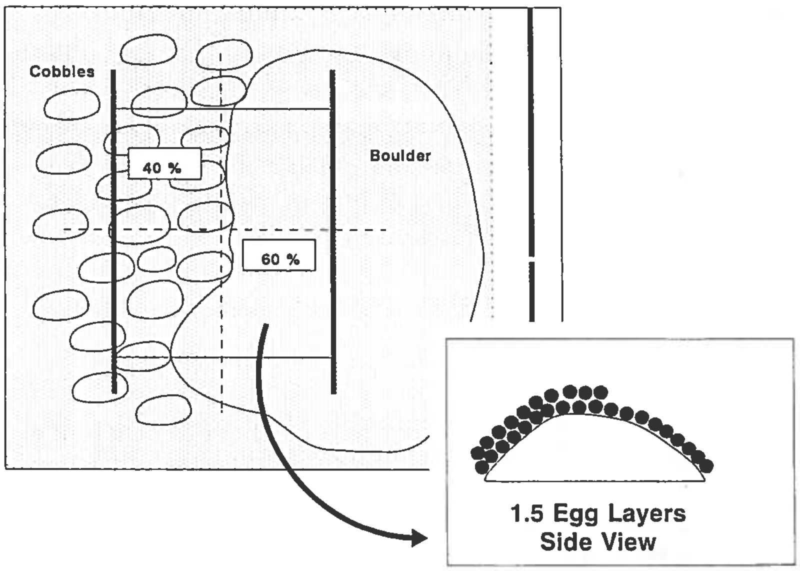


Figure 6 Bottom Spawn

Spawn On Vegetation

To place the quadrat, position it along the left side of the transect next to the appropriate mark, then flip it once to the left. This sets the station in an area where the vegetation is undisturbed by the lead line sweeping back and forth as it is set. It does not matter if the middle or one corner of the quadrat is positioned next the designated mark, as long as you are consistent throughout the transect. **DO NOT** shift the quadrat over because ""the spawn"s thicker over there"". This is a sampling scheme, and it is as important to sample the ""holes"" as it is to sample the areas with heavy egg deposition.

Understorey fields have had changes similar to bottom spawn fields. If a vegetation type is present with no spawn on it, **do not** record it, either as a vegetation type or as 0 cover or 0 layers.

Vegetation Types

Only vegetation with spawn is recorded. The vegetation types are listed at the bottom of the Transect Observation Sheet, and are presented below roughly as you would find them moving from deep to shallow water.

Deep spawns are often found on flat kelps (KF). These kelps have long (up to 2 metres) blades attached directly to the holdfast which fastens them to the bottom. They are too fragile to withstand the wave action found closer to the surface.

Closer to shore, leafy algae (LA), stringy algae (SA), and Sargassum (SM, also known as Japanese Weed), appear. Leafy algae looks like leaf lettuce, and comes in shades of green, red, or brown. Stringy algae likewise appears in a similar range of colour. One form looks like fir branches.

Stalked kelps (KS) are found on rocky exposed areas on the outer coast. These plants carry fronds on the end of an extremely tough stalk about 0.5 to 1 metre tall. Some species resemble miniature palm trees.

Coastwide, sea grasses (GR) are used by spawning herring more often than other vegetation types. Two forms are found, both in shallow water. The most common grows on mud/sand flats in protected locations while the other prefers rocky crevices exposed to surf.

Rockweed (RW), is an intertidal plant found quite close to the high water mark.

Grunge (GG) defies description. We use this category about six times a year for spawn found on leaves, bark, garbage, sponges, or toilet seats.

Percent Cover

If a plant type has spawn on it, estimate how much of the quadrat is covered by that plant. One way to do this is to mentally divide the quadrat up into quarters, and estimate how many quarters would be filled by that plant type. Do this separately for each plant type. **Unless** stalked or flat kelp are present, **the total cover in the quadrat cannot be more than 100%.**

With the exception of kelps, remove any unrooted plants or plants rooted outside the quadrat from within the quadrat before estimating percent cover. If a plant occupies less than 5% of the quadrat lump it in with the dominant type it most resembles.

A kelp plant rooted inside the quadrat usually has blades that extend well past the edges of the quadrat. To compensate for this ""extra"" bit of plant, ***do not*** remove the blades of kelps rooted outside the quadrat before estimating the percent cover. Think of taking a knife and cutting a square out of the kelp covering the quadrat. Each complete layer of fronds in this kelp sandwich is equal to 100% cover. Three complete layers of kelp in the quadrat then corresponds to 300% cover.

Layers

During spawning, female herring repeatedly pass over the substrate, building up the spawn into layers as they go. To estimate the number of layers, rip a ""leaf"" off a typical plant and look at it from the side or end on, so you can count the layers in cross section. If the ""leaf"" is flat, count the layers on both sides; if stringy (round), count the layers across the diameter as shown in below.

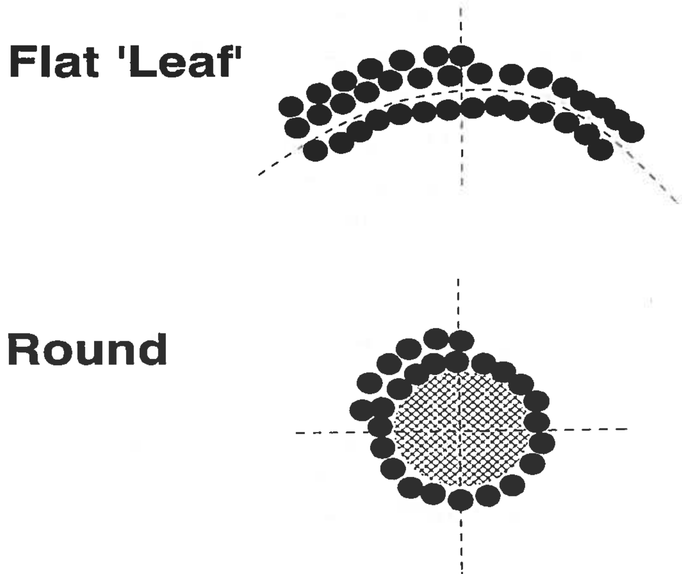


Figure 7 Two and a half Egg Layers

Height

For all plants except kelps, plant height is the distance from tip to substrate. As with layers, choose several ""average"" plants to measure. Measure only plants rooted within the quadrat (except for kelps, below).

For flat and stalked kelps, measure the length of several of the kelp blades passing through the quadrat (i.e.: the blades do not have to be rooted within the transect). For stalked kelps, ignore the stalk and measure the blade only.

Inner Edge of Spawn

Adding the distance from the last station to the edge of spawn to the distance recorded for the last station (Figure 3) gives the total transect length.

No Spawn

Even if you do not find spawn anywhere along the transect, we still need a data sheet. This type of transect is recorded as having no stations and a Total Width of 0 metres.

Drift and Windrows

Waves will often tear spawn loose from vegetation so that it collects in sandy troughs or rock crevices along the transect. If you find this, note it as a comment on the data sheet. Estimate the width and thickness of the drift, type of vegetation, percent cover, and layers, if possible.

Loose spawn may be rolled or piled up at the top of the beach during a storm. The amount of spawn in such a windrow can be estimated from its length, average width, and average depth. Again, record this data under ""Comments"".

Herring Mortality (Strait of Georgia Only)

We would like to collect data on herring mortality in spawn beds in the Straight of Georgia. This will be compared with similar data collected in the 1980's.

The procedure should not interfere with the regular collection of herring spawn data. Divers will keep a tally of any dead herring observed within 1 metre of the transect, and enter a total for the transect under "Comments"

Macrocystis Kelp

Macrocystis kelp is found in exposed areas of the outer coast. It does not occur in the Strait of Georgia region. A Macrocystis plant (Figure 7) has a root-like holdfast attaching it to the bottom. From this, several stipes (fronds) grow towards the surface. A single stipe consists of a vertical stalk growing up from the holdfast with large, flat blades extending horizontally from it at regular intervals.

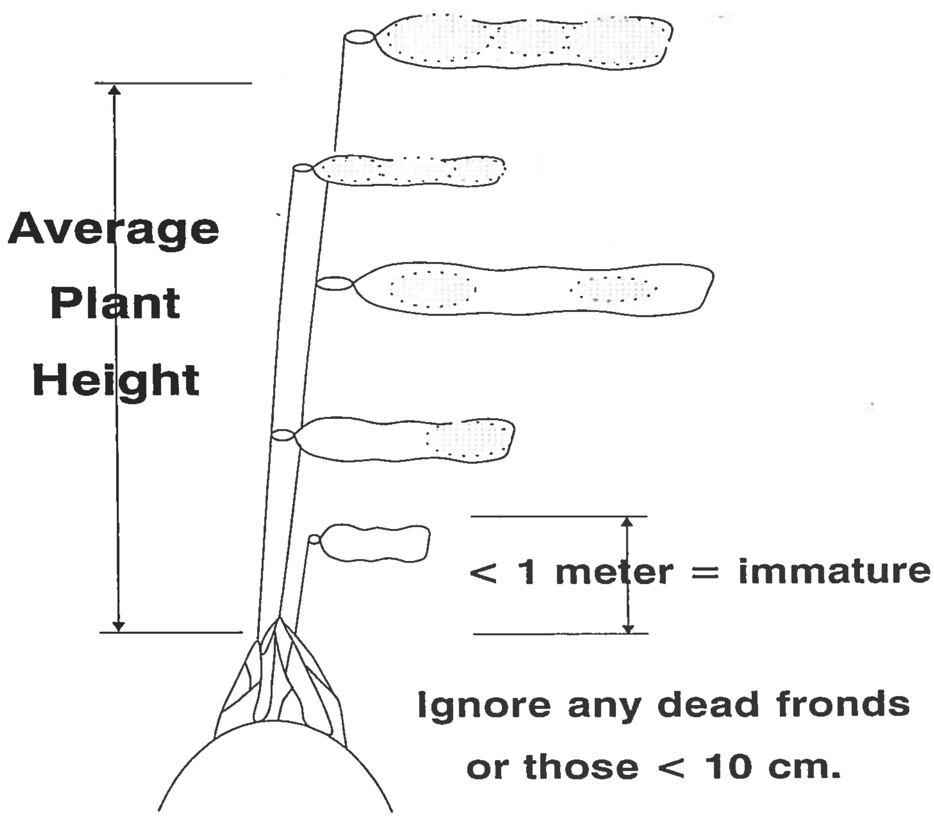
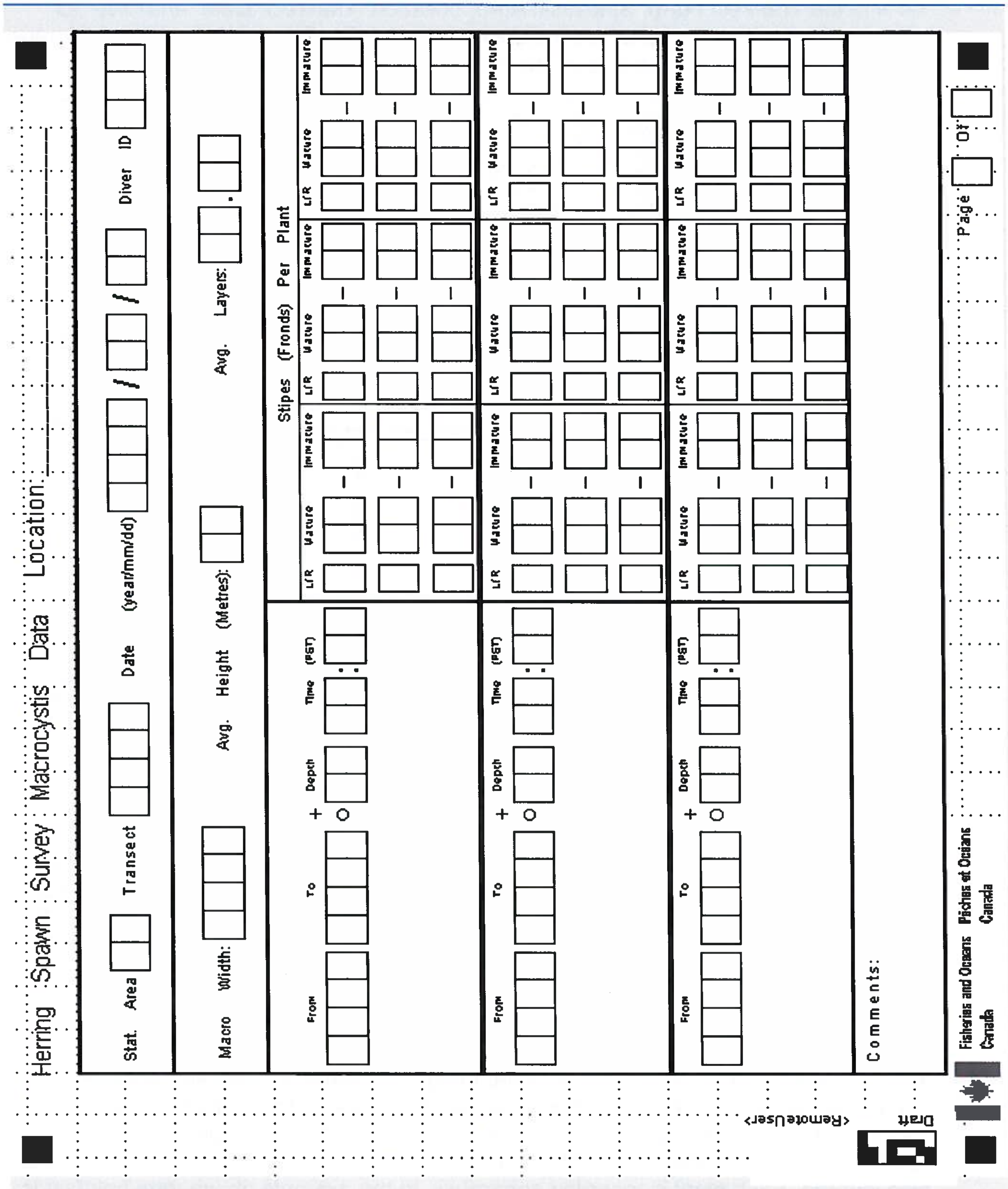


Figure 8. Macrocystis Plant: 3 Stipes, 2 Mature, 1 Immature

Spawn on Macrocystis kelp is treated as a separate spawn from that found on rocks or understorey vegetation, and is surveyed differently from these. Instead of using quadrats at placed at regular intervals a census is taken of all plants found within a two metre wide strip through the kelp bed. The form used by the Macrocystis recording diver is shown in Figure 8.



Herring Spawn Survey Macrocystis Data Location:

Stat. Area Transect Date (year/mm/dd) Diver ID

Macro Width: Avg. Height (Metres): Avg. Layers:

From To + O Depth Time (PST)

Stipes (Fronds) Per Plant

L/R Mature Immature

Comments:

Page of

Fisheries and Oceans Canada Pêches et Océans Canada

<RemoteUser>

Draft

Figure 9. Macrocystis Data Sheet

As with the Transect Form, Statistical Area, Location, Transect, Date, and Diver ID must be filled in at the start of the transect. Macro Width, Average Height, and Average Layers are filled in once the end of the macrocystis bed has been reached.

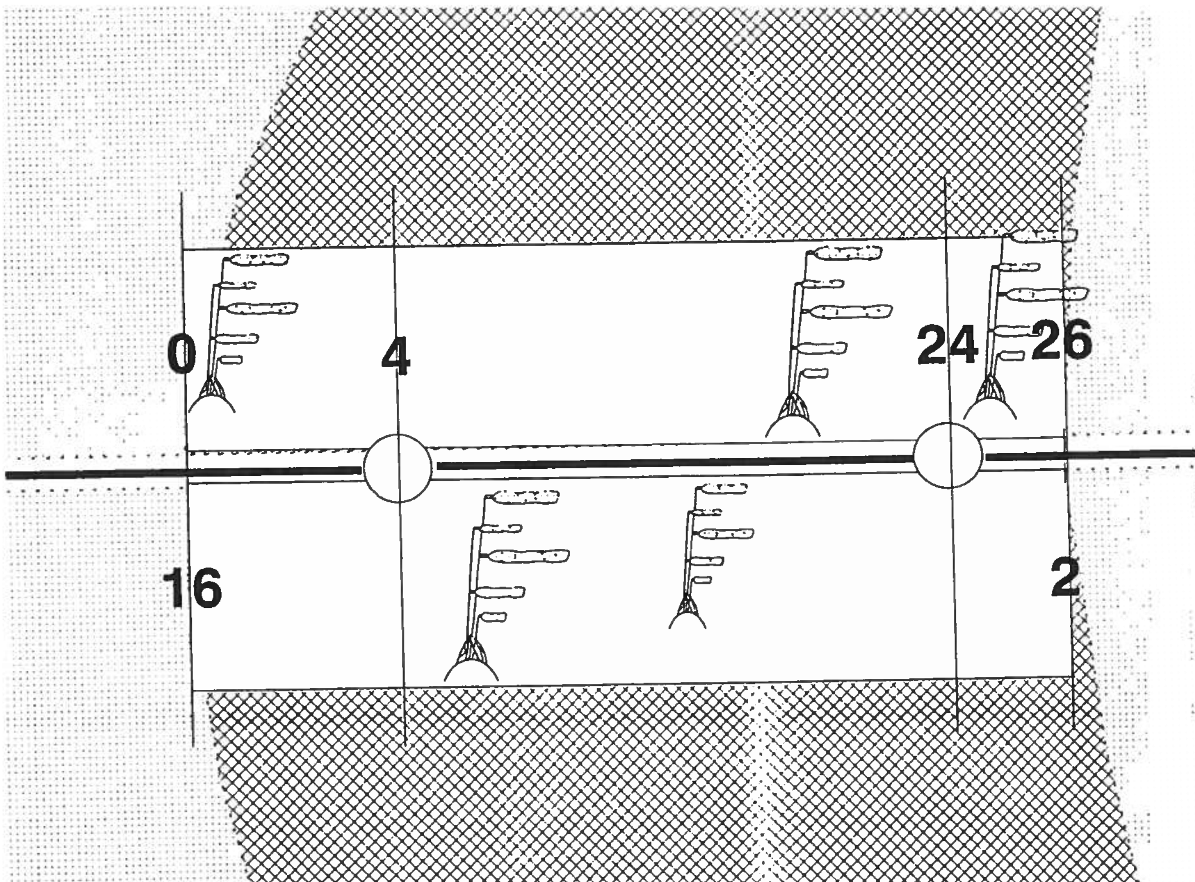


Figure 10. Macrocystis Transect

Swimming in along the transect, the diver will come to the edge of the kelp bed (Figure 9). This is the 0 mark for the bed. Usually, it is easiest to record the plants found from 0 to the first shackle, then every shackle thereafter. In Figure 9, the bed was encountered at the 16 metre on the first length of lead line, leaving 4 metres to the first shackle. As shown in Figure 8, this is recorded as the interval From 0 To 4 metres.

The Depth and Time is recorded at the start of the To/From interval, in this case at the 0 mark.

The stipes (fronds) are classified as either mature or immature, and are recorded separately, as herring do not usually spawn on immature stipes. Immature stipes are less than a metre high, and have a gummy coating, which is probably what inhibits spawning. Immature stipes less than 10 cm are ignored. Dead stipes with no blades are also ignored. Each plant is recorded separately. In the example above, one holdfast is found to the left of the lead line with 2 mature stipes and 1 immature stipe attached. DO

NOT “roll up” the plants. The two plants found on the right in the second interval MUST be recorded as 2-1 2-1, not as 4-2, which would make a single plant out of two.

The diver continues along the transect, recording plants at convenient intervals. To help estimate average height and egg layers keep a running tab of the average height and layers in each To/From interval in the space under the To/From boxes.

If only a few plants or a single plant in the bed it is possible to end up with a single interval of 0 to 1 metres. Occasionally the bed will be so dense that the recording diver will have to break the FROM/TO intervals into something shorter than 20 metres in order to have enough space to record all the plants present. If you end up with more than 9 plants in an interval, continue recording them in the next set of plant boxes, but leave the From/To, Depth, and Time boxes blank.

The next interval in the example above runs FROM 4 TO 24 metres (one shackle to the next). The bed then runs out 2 metres past the next shackle, which makes this interval run FROM 24 TO 26 metres, and gives a total bed width of 26 metres.

This survey can be speeded up by measuring your arm span on the surface. If, for example, you know the distance from your nose to your cuff to be 1 metre, you can quickly assess whether or not most holdfasts are within 1 metre of the lead line, and then have to measure only the borderline cases exactly.

Estimate average height the same way. Usually you can pace out an “average” plant with the metrestick. Again, be prepared to revise your estimate as you swim towards shore, as the smaller plants are often the ones on the fringes of the patch.

Bare spots in the kelp bed are recorded as TO/FROM intervals with no plants in them, or combined with intervals which have plants. In other words, the To/From intervals should be continuous until you each the end of the bed. It is not correct to show intervals of 0/20,20/35, then jump to 120/140,140/148. This usually happens when the macrocystis bed appears to end, then another band is encountered. In the example shown above, the second interval should be changed from 20/35 to 20/120, to account for the empty band.

Herring will often spawn so heavily on Macrocystis that the plants end up weighed down in a huge tangled pile on the bottom. If you cannot get through the mess far enough to find holdfasts and individual plants, make your observations passing over the bed as best you can. Again, COMMENTS are necessary if you have to do this.

Summary Information Form

In some circumstances this information can be shown on the spawn charts and this sheet omitted.

Herring Spay Survey Summary Data

Year | | | | | Stat. Area | | | Survey Number | | |

Location	Spawning Dates (Mon/Day)		Total Length (Metres)	Understorey Length (Metres)	Macrocystis Length (Metres)
	Start	End			
	/	/			
	/	/			
	/	/			
	/	/			
	/	/			
	/	/			
	/	/			
	/	/			
	/	/			
	/	/			
	/	/			
	/	/			

2759

Comments:

Fisheries and Oceans Canada   Pêches et Océans Canada

Year and Statistical Area must be filled in. The Survey Number is a unique number assigned to each dive survey vessel depending on the survey area:

41	Queen Charlotte Islands
42	Prince Rupert
43	Central Coast
44	Central Coast and Strait of Georgia
45	Strait of Georgia
46	Strait of Georgia
47	South West Coast Vancouver Island (Barkley Sound)
48	North West Coast Vancouver Island
51	Shorebased (West Coast Vancouver Island and Strait of Georgia)

Location names are shown on permanent transect charts. If there are multiple spawnings or significant gaps in the spawn (700 metres or greater) at a particular location then there will be more than one summary record for that location.

Spawning Dates are the start and end of spawning activity at that location. These must be obtained from DFO field offices before the survey vessel leaves the grounds.

Total Length is the "beach length" of spawn, and is usually the same as the Understorey Length. The total length is the length of spawn measured along the depth contour where most of the spawn is found. There are occasions where a

Figure 11 Spawn Summary Sheet

bottom/understorey vegetation spawn ends but continues on Macrocystis kelp. In this case the Total Length would be the Understorey Length plus the extra length to the end of the kelp bed.

Macrocystis Length is the length of the Macrocystis beds within a particular location, mapped separately from bottom and vegetation spawns.

In past years the Summary Form has included fields to record the transect numbers surveyed at each location. With the shift to permanent transect numbers it is no longer necessary to record this data on the summary sheet. It should however, be recorded in the daily log (hard cover book in the data briefcase) as part of the record of daily survey activities, i.e.:

98/Apr/01 Frog Cove Transects 2066-2078 and 2100 completed.

DATA ENTRY PROGRAM

Installation

The data entry program (HSD Entry Program) is supplied on a single DVD and on the USB flash drive supplied for transferring data to P.B.S.

If the program needs to be installed on a new computer please confirm it works with the new computer well before the start of the trip and contact Charles Fort at P.B.S. if it is not.

Please make sure that other window applications like Outlook and Word are closed before you start the installation.

1) Place the DVD into the DVD drive or the USB flash drive into a USB drive. Unlike past version of the data entry program an autorun installation window will not pop up immediately when the DVD is put into the DVD drive.
2) Open Windows Explorer, find and click on the DVD drive "SpawnDive 2010" or USB drive.
3) In the main directory select (double click) "Setup.exe".
4) Follow the installation directions. Normally, select "A Typical Installation".
5) Once the installation is complete, Two windows will pop up saying SpawnDive 2010 was successfully installed. A "SpawnDive 2010" shortcut will be installed on the computer's desktop.
6) The new spawn entry program automatically picks where the spawn dive data will be stored. The database file is located in:
7)

C:\Documents and Settings\UserName\My Documents\SpawnDive2010\SpawnDiveData 2010.mdb

Data Entry

Sheets are filed in the data binder in the following order for each statistical area:

1) Summary Sheets (If used. If not, this data must be written on spawn charts).
2) Spawn charts. Sort by permanent transect chart number.
3) Surface survey sheets, if used.
4) Miscellaneous documents, usually overflight charts,
5) Transect and macrocystis data sheets, sorted by transect number, transect sheet first followed by macrocystis sheet for each transect.
6) Dive logs, sorted by date.

Data entry requires the summary data for a location to be entered first, followed by transect observation sheets, and finally macrocystis sheets. This order allows the program to connect the records together properly.

Survey data must be entered into the computer as soon as possible, preferably the day it is collected. Garbage data is easier to spot and correct this way.

Before entry sort the data sheets and check for missing data sheets, blank spots in the data, or other problems. Remove data sheets for transects falling outside the ends of spawn and retain 0 length transect sheets for empty patches within the spawn bed

If incorrect data needs to be changed confirm the changes with the recording diver, then with a single line strike out and correct the original entry. If extensive re-writing is required, transfer the corrected data to new sheets, and either dispose of the old sheets, or write “Void” on the old sheets to avoid confusion.

The program must be shut down properly when data entry is finished. Do not shut off the computer until you have exited both the program and Windows itself.

Data Backup

The current version of the data entry program does not have a backup utility. At the end of a data entry session (or the end of each day) copy/paste or drag and drop the SpawnDiveData2010.mdb onto the USB flash drive.

The SpawnDiveData2010.mdb is in the “C:\Documents and Settings\UserName\My Documents\SpawnDive2010”.

Please rename these files as xxMonthDay.mdb, where xx = your survey number. For example, if you are survey 42 your backup for April 02 would be 42Apr02.mdb. This makes it obvious which files are the most recent.

Saving and Transferring Data

Return the data briefcase with the USB flash drive, data sheets and other paperwork in the data briefcase as soon as possible to the Pacific Biological Station, attention Charles Fort or Matthew Thompson.

Pacific Biological Station

Fisheries and Oceans Canada

3190 Hammond Bay Road

Nanaimo, B.C. V9T 6N7

A complete data package must include:

USB flash drive with the latest version of SpawnDiveData2010.mdb from your computer

Summary forms

Spawn charts showing ends of spawn

Transect forms (filed by Transect Number)

Macrocystis forms (following the Transect form for each transect)

Dive logs (filed by date)

Daily log (Digital copy)

If you have problems with the Entry program or you have to change the survey procedures in any way, contact:

Charles Fort,	P.B.S.	(250) 756-7259
	Home	(250) 468-5635
	Cell	(250) 616-7497
Matthew Thompson	P.B.S.	(250) 756-7082
	Cell	(250 714-6004

REFERENCES

Emmett, B. and H. McElderry. 1985. A Manual for Diver Surveys

of Herring Spawn. Unpublished manuscript prepared for Department of Fisheries and Oceans.

Haegele, C.W. 1988. FODS: A Guide. Unpublished manuscript.

Midgley, P. 2003. Definitions and Codings of Localities, Sections, and Assessment Regions for British Columbia Herring Data. Can. MS Rep. Fish. Aquat. Sci. 2634. 113 p.

Humphreys, R.D. and A.S. Hourston. 1978. British Columbia Herring Spawn Deposition Survey Manual. Department of Fisheries and the Environment, Fisheries and Marine Service.

Misc. Special Publication 38: 40 p.

Outram, D.N. 1955. The Development of the Pacific Herring Egg and its Use in Estimating Age of Spawn. Fisheries Research Board of Canada. Circular No. 40.

Loegering, John P., 1997. Wildlife Mortality and Entanglement by Discarded Hip Chain String. Wilson Bull., 109(2), 1997, pp. 353 – 355.

Worker's Compensation Board of British Columbia. 1999. Occupational Health and Safety Regulation, Industry/Activity Specific Requirements Parts 20 – 33.

APPENDIX A: Herring Spawn Survey Safe Diving Procedures

General Requirements:

ALL DIVES MUST COMPLY WITH W.C.B. of B.C. REGULATIONS. Any omissions in this document of generally accepted safe diving practices are not to be taken as a lack of endorsement of those practices.

In the following paragraphs the reference numbers in brackets indicate the relevant sections of the "Occupational Health and Safety Regulation - Industry/Activity Specific Requirements" published by the Workers Compensation Board of British Columbia (1998).

Dive Supervisor:

The Dive Supervisor is responsible for all diving activities, ensuring that all safety and survey protocols are followed by dive teams. It is the Dive Supervisor's responsibility to train divers, tenders, and compressor operators as required and ensure that their duties are carried out correctly. (24.8, 24.18-24.19)

Dive Teams:

A standard dive team consists of two divers and a tender operating from a single skiff. Each support vessel (mother ship) has two such teams working closely together on the spawn beds (usually on adjacent transects). In any event the two dive skiffs are to remain close to each other. In areas of deeper spawn (Queen Charlotte Islands and Barkley Sound) it is sometimes necessary to have three or four divers rotating dives from one skiff in order to minimize nitrogen buildup on multiple 'deep' dives (below 40 feet).

Diver Equipment:

Refer to (24.38) for dive gear requirements.

- All divers are to carry a watch.
- Depth gauges are to be tested at the start of the survey (24.29).
- Diver to tender signalling devices (whistle, "safety sausage"" or orange garbage bag, flare, or strobe) are now required for open water dives.
- Buoyancy Compensation Devices are now required "appropriate to the diving conditions" (24.38). In kelp beds, extra care must be taken to secure inflator hoses and loose straps.
- Divers are to be weighted to maintain neutral buoyancy in 10'/3m of water with 500 p.s.i./35 bar in the cylinder. This allows divers to comfortably complete stations in shallow water near the end of a dive without buoyancy problems.

Kelp:

- Divers will carry at least one entanglement knife, secured on the upper body where it is accessible without twisting.
- All extraneous gear, unused hose whips, etc. to be removed or secured.
- Reverse or tape tag ends of fin, mask and knife straps.
- Kelp survey should be done by divers experienced in kelp environment.

Tender Skiff:

- Tender vessel must be capable of landing safely on a beach and working in shallow water.
- Tender vessel must have a working depth sounder.
- Tender vessel is to have a working vhf radio or other means of signalling the support vessel in case of emergency. Radio standby on channel 16 or previously arranged working channel. Signalling device must remain effective after immersion in salt water (as in capsize). Tender vessels over 6 metres in length must be equipped with an EPIRB.
- Field O2 kit (E or D cylinders) and Level 1 first aid kit to be carried during diving operations.
- A throw line to assist recovering divers is required.
- When recovering divers the skiff's engine is to be shut off before the divers approach the skiff, unless working in a surf zone or other area where it might be necessary to move the skiff immediately once the divers are back on board.

If it is necessary to tow divers (out of a surf zone or macrocystis bed), the dive tender will either:

a) travel in reverse if the divers are hanging onto the skiff's gunwales, or
b) use a towline so that the divers are towed astern well clear of the skiff's propeller.

Diver Tender:

- Diver tenders require adequate exposure protection to prevent hypothermia.
- Diver Tender is responsible for logging dives as they occur.
- Diver Tender will prearrange a diver recall signal with the divers before diving commences. This is usually a group of four signals – hammering on the hull or revving the engine, for example. The most effective recall is setting off a diver recall signal.

Sea Lions and Diver Recall Signals:

Increasingly aggressive behaviour by sea lions in the Strait of Georgia may require the a location to be cleared with dive recall signals before the divers can work. Use the minimum necessary to accomplish this task and log all SDR use so we can track their effectiveness. If SDRs become ineffective other strategies will need to be developed to dive safely around sea lions.

Use the following procedure to deploy an SDR:

- Safety glasses should be used.
- Ensure that there are no fuel vapours or spilled fuel present.
- Select a location on the boat well away from fuel vents, fill pipes, or engines. The bow is often the safest place to work from.
- Open the SDR storage box, remove one SDR then close and latch the box.
- Holding the SDR outboard of the gunnels, use a windproof lighter to light the fuse or the striker cap to light the self-striking SDRs.
- Immediately drop the SDR into the water or toss it a safe distance from the divers. The fuse has a 5 to 7 second delay.
- Self striking SDRs should be deployed no closer than 5 metres from divers, the fuse model is somewhat stronger and should be kept at least 10 metres from divers.

Support Vessel:

- Anchored close to daily worksite (within visual range, if possible without compromising the vessel's security).
- VHF channel 16 or previously arranged working channel to be monitored during diving operations.
- Oxygen "sufficient to last throughout an evacuation" must be carried. This is usually a large medical O2 cylinder - ""M""/625 litre cylinder or greater.
- To minimize the risk of hypothermia, an enclosed changing area for divers is required. This may be a ladder into the hold, easy access to engine room (while wearing dry suits), or an enclosed area on deck.
- Fresh water source available on deck for rinsing gear at end of day's operations.

Compressor :

- See B.C. Occupational Health and Safety Regulations reference 24.26, 24.28.
- Certificate showing compressor air has passed CSA standards (CSA/CAN Z275.2-04 or CSA/CAN Z180.1-00 "Compressed Air for Diving") within the last year must be available on board.
- Air intake for compressor must be kept clear of contamination from main and auxiliary engine exhaust, galley stove stacks, and tender vessels. Carry enough

intake hose to rig air intake from well forward of these sources. DO NOT exceed the compressor manufacturer's recommended maximum intake hose length and diameter.

- Operators must be briefed on proper operation procedures, including:
  a) Checking intake for sources of contamination.

  b) Checking oil, and the correct type of oil used in breathing air compressors.

  c) Blowing water out of valve stems before attaching tanks to fill whips.

  d) Correct fill pressure for tanks used by team.

  e) Maintaining the filters in operating condition by bleeding condensate every 10 to 15 minutes as recommended by manufacturer.

  f) Monitoring hours of compressor use and filter change intervals.

Dive Procedures:

- Hours of operation: Daylight only: 0730 - 1900 PST (1700 on days of low light/visibility)
- Divers can expect to make 2 to 10 repetitive dives per day, depending on location.
- All dives will be no decompression dives, using the DCIEM tables or other WCB of BC approved table (written exemption required).
- Dive logs are to be kept current at all times.
- Computers to be used ONLY as a backup to dive logs and tables.
- Dives to be logged as square dives, bottom time = start of descent to time diver"s head appears at surface. This discounts offgassing time at shallow (< 3 msw) stations and increases the safety margin for multiple dives.
- Where a repetitive dive's repetitive group letter is less or equal to that of a preceding dive, divers will follow the correct procedure to avoid Repetitive Group loops (DCIEM Diving Manual, 1-24).
- Spot diving to locate ends of spawn or location of spawn below 60 feet:
  a) Use either buddy pair or single diver secured to a buoy line.
  b) Ascent rate NOT to exceed current DCIEM recommendations - 15 metres (50 fsw) per minute, +/- 3 metres/10 feet per minute.
  c) Work across or up the slope (deep to shallow).

  d) Difference between maximum depths during a series of dives is not to exceed 12 metres / 40 feet.

- Seaward end of transect will be dropped at a maximum depth of 20 metres, using depth sounder, and marked by a buoy with a maximum of 20 metres of line.
- Descent rate is not to exceed 18 metres / 60 fsw per minute.
- Divers work upslope from deep to shallow, not exceeding 18 metres / 60 fsw per minute ascent rate.

- Solo diving (24.35) is only permitted if:
    a) the diver has a buoy and line to the surface clipped securely to his/her equipment OR is in constant audio communication with the tender.
    b) no macrocystis kelp or other entanglement hazard is present.
    c) a dressed standby diver is available in the tending skiff.
    d) the skiff tends only one solo diver at a time.
    e) the dive does not exceed 20 metres / 60 feet.

All incidents (accidents or near-misses) are to be logged.

APPENDIX B: Emergency Contact Information

Diver Emergency Evacuation Procedures

Any injury to a diver who has been diving within the last 24 hours is treated as a diving-related injury.

Primary Evacuation Procedure

Rescue Coordination Centre: 1-800-567-5111

1-250-413-8933

Cellular: # 727
INMARSAT C: POR 582 - 431699933

CCG: VHF 16 (156.8 MHz.)

MF 2182 kHz.
Cellular: *16 (no direction finding, access not provided by all service providers)

- State: "THIS IS A SCUBA DIVING EMERGENCY".
- Have victim's ID, dive computer, and ALL dive logs ready for evacuation with victim.
- If possible, dive supervisor should evacuate with injured diver.

Secondary Contacts: Shoreline Evacuations, Medical Advice and Recompression Chambers

B.C. Ambulance Service: 911
Air Ambulance: 1-800-461-9911

Fleet Diving Unit (Chamber, 24 hrs) (250) 363-2379
Dr. Don Krawciw (250) 920-6421
Base Switchboard (250) 363-2000

Vancouver Gen. Hospital (604) 875-4111
Call the above number, ask for the emergency hyperbaric physician on call.

Juneau Hospital (907) 796-8427

Divers Alert Network (919) 684-9111
Toll Free

Post-Accident Procedure

Secure victim's equipment. Do not disassemble. Do not close valves unless air leak is present. Document valve positions and cylinder pressure as part of initial incident investigation notes.

Notify: Supervisor Science Branch Diving Officer - Charles Fort (250) 756-7259 Cell: (250) 616-7497

Severe injuries/death: HRSDC (D.F.O. employees): (604) 872-4384 WorkSafe B.C. (Provincial workers): 1-888-621-7233 or 1-866-922-4357 (after hours)

Current as of: Jan 17th 2013

HOSPITAL CONTACTS
Coastal B.C. Dive Locations

QCI / Haida Gwaii

Masset

Northern Haida Gwaii Hospital and Health Center:

Masset
2520 Harrison Ave
250-626-4700

Village of Queen Charlotte

Queen Charlotte Islands General Hospital
3209 Third Avenue
250-559-4301

North Coast

Prince Rupert

Prince Rupert Regional Hospital
1305 Summit Avenue
250-624-2171

Kitimat

Kitimat General Hospital
920 Lahakas Blvd South
250-632-2121

Central Coast

Waglisla (Bella Bella)

R.W. Large Memorial Hospital

88 Waglisla St

250-957-2314

Bella Coola

Bella Coola General Hospital
Mackay Street
250-799-5311

Vancouver Island North

Port Hardy

Port Hardy Hospital
9120 Granville Street
250-902-6011

Port McNeill

Port McNeill and District Hospital
2750 Kingcome Place
250-956-4461

Alert Bay

St. George"s Hospital
49 School Road
250-974-5585

Campbell River

Campbell River and District General Hospital
375 - 2nd Avenue
250-850-2141

West Coast Vancouver Island

Kyuquot (Nurse on call 24 hrs.)
VIHA Kyuquot Outpost Hospital
100 Okime Street
250-332-5289

Tahsis

Tahsis Health Centre
1085 Maquinna Drive
250-934-6322
1-888-915-5204 (Pager – leave name & number only)

Tofino

Tofino General Hospital
261 Neill Street
250-725-4010

Bamfield (Nurse on call 24 hrs.)
VIHA Bamfield Health Center
365 Bamfield Rd
250-728-3312

Port Alberni

West Coast General Hospital
3949 Port Alberni Highway
250-731-1370

Strait of Georgia West

Comox

St. Joseph"s General Hospital
2137 Comox Avenue
250-339-2242

Nanaimo

Nanaimo Regional General Hospital
1200 Dufferin Crescent
250-755-7691

Ladysmith

Ladysmith Community Health Care Centre
1111 - 4th Avenue
250-739-5777

Chemainus

Chemainus Health Care Centre
9909 Esplanade Street
250-737-2040

Duncan

Cowichan District Hospital
3045 Gibbins Rd
250-737-2030

Saltspring Island

The Lady Minto Gulf Islands Hospital
135 Crofton Road
250-538-4800

Saanichton

Saanich Peninsula Hospital
166 Mt Newton X-Road
250-544-7676

Victoria

Victoria General Hospital
1 Hospital Way (Off Island Highway)
250-727-4212

Royal Jubilee Hospital
1952 Bay Street
250-370-8000

The Gorge Road Hospital
63 Gorge Rd E
250-995-4700

Strait of Georgia East

Powell River

Powell River General Hospital
5000 Joyce Avenue
604-485-3211

Sechelt

St. Mary"s Hospital
5544 Sunshine Coast Highway
604-885-2224

Vancouver

Vancouver General Hospital
855 W. 12th Avenue
604-875-4111

Last Update: Jan 17th 2013

APPENDIX C: Surface Survey Protocol

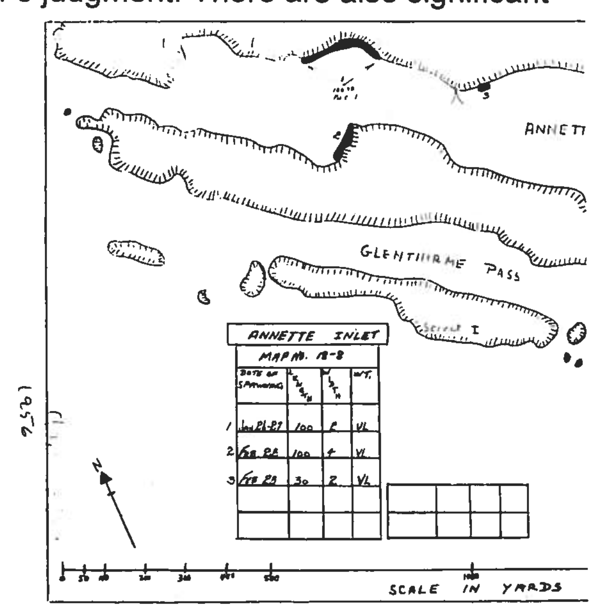
Herring spawning events on the B.C. coast have been recorded since 1928. Over the years these records evolved from simple presence/absence to more detailed measurements that could be used to estimate the tonnes of herring spawning on a section of beach. For many years before the widespread availability of SCUBA spawn surveyors were limited to observing spawn from the surface at low tide, through glass bottom buckets, and with grapples dragged through vegetation beds.

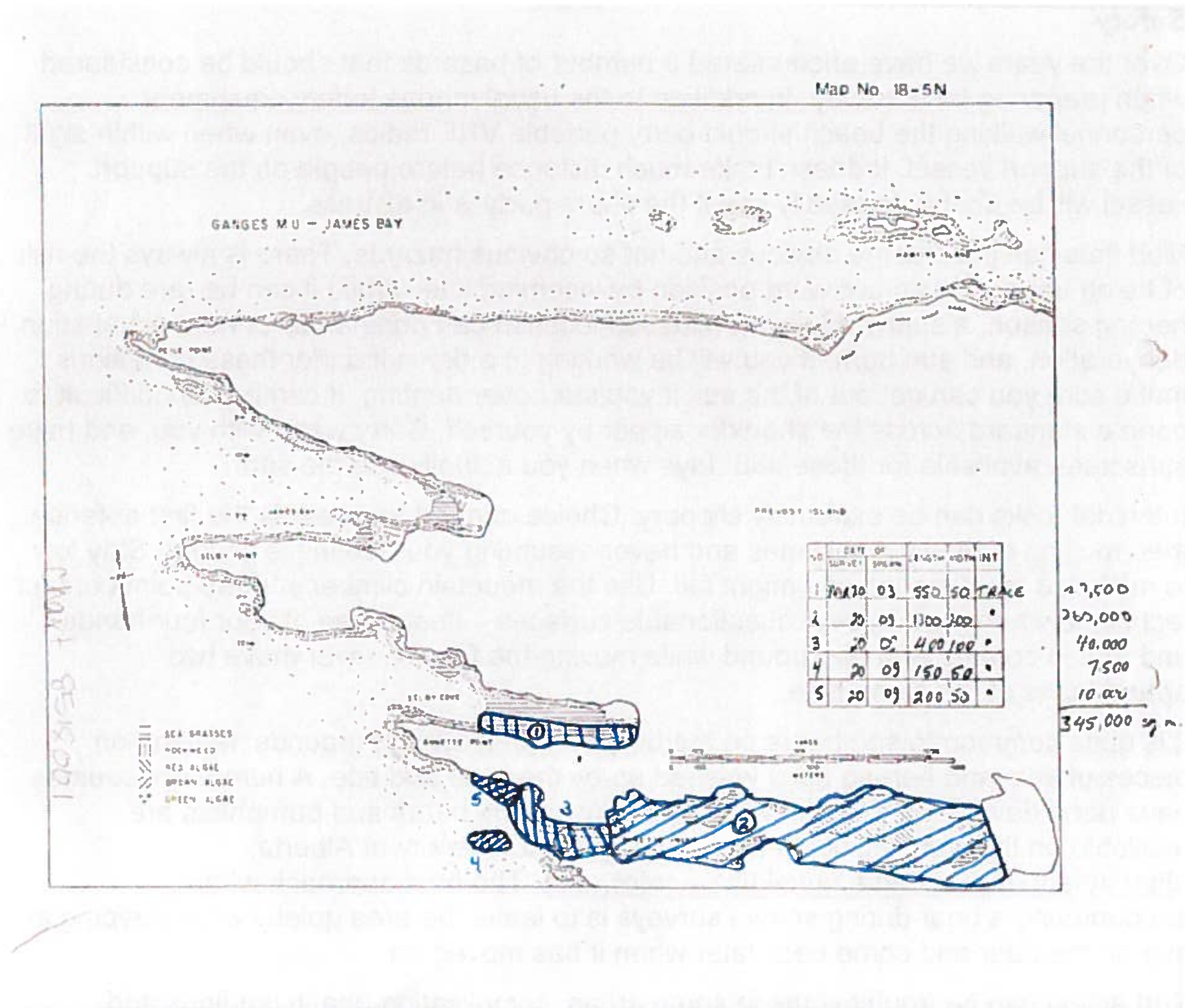
Early work with SCUBA in the nineteen seventies showed that in some locations significant portions of the spawn beds lay undetected in deep water beyond the limits of visibility and on substrate which could not be grappled. In the mid eighties a sampling protocol was developed and tested using SCUBA divers to collect observations, resulting in more accurate tonnage estimates. Dive surveys were adopted for all major herring spawn beds by 1988. Surface surveys continue to be used in minor areas where divers are not available.

In some locations surface and dive surveys will produce similar results. Narrow bands of spawn high up in the intertidal zone on rockweed or on eelgrass on shallow mudflats can be seen and assessed at low tide by surface surveyors as effectively as by divers. In other areas more than 60% of the spawn may be below 15 feet. This can result in the surface survey missing a large part of the spawn bed and under estimating spawn bed width. This, coupled with the dive survey's more rigorous sampling protocol, makes dive surveys the preferred method for most spawn surveys. The only advantage of now of surface surveys is the lack of dependency on divers and the specialized training, equipment, and insurance considerations that go along with them. Time-wise there is no advantage to a surface survey as it can be very time-consuming to develop an accurate picture of a complex bed from the surface.

Surveyors with dive survey experience can expect to be confused by some of the differences between the two protocols. A dive survey works off regularly spaced transects and sampling stations, while for a surface survey what constitutes a "record" or sampling interval is left up to the surveyor's judgment. There are also significant differences between the vegetation classes, although the basic principles of evaluating egg layers remain the same.

These differences aside, both surveys face the same basic tasks; the spawn must be mapped, measured, and intensity estimated. The chart to the right shows a surface survey record from 1956. During this period spawn location was recorded along with spawning dates, lengths, and widths. Spawn deposition was graded in five categories from very light to heavy, instead of counting the egg layers as we do today.





This chart from 1985 shows spawn mapped on a vegetation chart. These vegetation charts were developed from aerial photographs during the nineteen seventies as an aid to spawn surveyors and still show up from time to time in field offices. Notice how careful the surveyors were to map small but distinct beds like #4.

Safety

Over the years we have encountered a number of hazards that should be considered when preparing for a survey. In addition to the usual marine safety equipment personnel walking the beach should carry portable VHF radios, even when within sight of the support vessel. It doesn't take much distance before people on the support vessel will be unable to readily see if the shore party is in distress.

Mud flats can pose some obvious and not so obvious hazards. There is always the risk of being trapped in an awkward position by incoming tide. While it can be rare during herring season, a sunny day in an exposed location can pose a risk of heat exhaustion, dehydration, and sun burn. If you will be working in a dry suit under these conditions make sure you can get out of the suit if you start over heating. It can be very difficult to open a standard across the shoulder zipper by yourself. Carry water with you, and have sunscreen available for those odd days when you actually see the sun.

Intertidal rocks can be extremely slippery. Choice of good footwear is the first defense, then moving carefully at all times and never assuming your footing is secure. Stay low to minimize the distance you might fall. Use the mountain climber's "three point contact" technique when moving over questionable surfaces – keep three of your four hands and feet in contact with the ground while moving the fourth, never move two appendages at the same time.

It is quite common to see bears on the beach near spawning grounds, feeding on pieces of kelp and herring eggs washed up by the wind and tide. A number of courses have been developed to teach working safely around bears and pamphlets are available on the web, including this one from the University of Alberta: http://safety.eas.ualberta.ca/field/bearsafety.cfm The best approach when encountering a bear during spawn surveys is to leave the area quietly while keeping an eye on the bear and come back later when it has moved on.

Surf action can be troublesome in some areas, complicating beach landings and washing surveyors off rocks. A life jacket will not only keep you afloat under these circumstances, but also help cushion your fall if you slip. We have had one instance of an inflatable capsized in surf by a large wave breaking outside the normal surf zone.

Spawn rakes are usually thrown out from the boat in order to help keep the tow line clear of the propeller. Throw the rake so it won't hit other personnel if it slips out of your hand during the cast. If the boat is small and crowded just drop the rake over the side.

Laser range finders are usually Class 1 lasers, meaning there is minimal risk from eye exposure. Never the less, instructions with these units usually include eye exposure warnings. Be sure to read and follow them, and avoid pointing a laser range finder directly at someone's head.

Tools

1) Spawn rake

The rake shown below is a design which has proven to be effective over a long period of time. Oddly enough, the uglier the rake, the more effective it is, as the slag left from the cutting torch helps to grab and hold vegetation. A large treble hook can be used if a spawn rake is not available.

2) Waterproof notebook or forms

"Rite in the Rain" all-weather copier paper (item No. 8511) can be used in most photocopiers and laser printers to produce your own survey forms.

3) Charts

Use Zip-Lock bags to protect paper charts.

4) Bathyscope

These are often available through marine chandler stores. The dark blue models shield the viewplate better from distracting reflections than the orange model show.

5) Buoys

These are used to mark the edges of the spawn bed and as references for measuring distances. Reflective tape will increase the range they can be used with a laser rangefinder.

6) Laser (or optical) range finder

Good laser rangefinders are available for around $300, accurate to +/- 1 metre with a range from 5 to 200 metres and possibly up to 800 metres, depending on the model and the reflectivity of the target.

7) Surveyor's (fiberglass) tape measure

A 50 metre tape is the most useful.

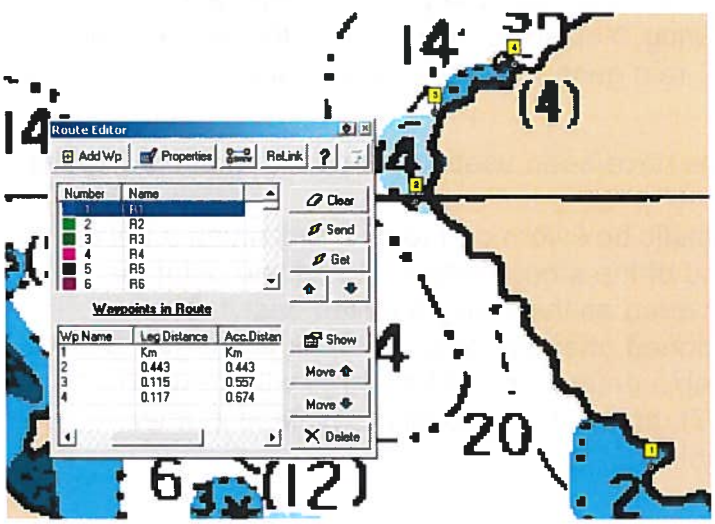
8) Handheld GPS Receiver

Useful for determining your position along relatively featureless coastlines. Generally accurate to +/- 20 metres. Differential GPS receivers can be accurate to +/- 5 metres.

Measuring Distances

Biologists, foresters, and geologists have developed a number of techniques for measuring distances in the field. It is important to understand the strengths and limitations of each in order to select the right technique for the circumstances.

1) Plot the two points on a chart, measure distance directly using calipers or a curvimeter on paper charts or measurement tools in electronic chart software. Accuracy depends on chart scale and measuring instrument used, and can vary greatly. This technique is only suitable for measuring spawn length along relatively straight sections and is very rarely precise enough for measuring width.



2) Handheld GPS receiver: Plot a waypoint and track the distance over ground between the start and end position. Depending on the receiver model we can expect resolution to +/- 20 metres, improving to +/- 5 metres if a differential GPS unit is used. As a general guideline, use GSP for measuring distances of 100 metres or greater, and DGPS from 25 metres up.

3) Laser range finder: Resolution depends on the model. One readily available model measures from 5 to 200 metres (800 metres with reflective target) with an accuracy of +/- 1 metre. This is ideal for measuring most spawn widths.

Laser range finders work best against a reflective target such as a buoy with reflective tape or a safety vest. These devices are usually a Class 1 laser outside the human visible range, so eye injury is unlikely; however, be sure to read and follow the instructions and avoid shining the laser directly at a person's head.

4) Optical range finder: a good choice to fill in the gap at the lower range of a laser range finder, from 0.5 to 10 metres.

5) Surveyor's tape measure: Cheap, effective, and more accurate than needed for spawn survey work. Tapes over 50 metres long can be awkward to handle on the beach.
6) Pacing: Pacing can be surprisingly accurate, if care is taken beforehand to calibrate one's pace accurately.

A pace is counted as two steps, that is, every time the left foot strikes the ground one pace is counted. To calibrate your pace, lay out a measured course, then walk it normally (without using an exaggerated step) counting how many paces in the measured distance. Divide the total distance by number of paces to get metres per pace. Repeat a number of times to check your accuracy and to help train yourself to maintain a steady pace while measuring. You should be wearing the same gear you will be surveying in, as rubber boots, rain gear, and especially neoprene dry suits will affect your pace.

7) Hip chains: Surveyor's hip chains have been used in the past to measure spawn beds.

A hip chain (a.k.a. string box) is a plastic box worn on the belt containing a roll of string and an odometer. With the end of the string fastened to a fixed point the odometer measures the distance covered as the string is pulled past it. The biodegradable cotton string is abandoned after use and will break down over time. It does, however, present a demonstrable entanglement hazard to wildlife while breaking down (Loegering, JP., 1997), and its use should be avoided if other measurement techniques are available.

Data Collection Priorities

It is not always possible to thoroughly survey every spawn bed. Usually though, any information is better than nothing, and we appreciate any spawn activity reports forwarded to the local Fisheries office or to the Pacific Biological Station. In order of priority, we try to collect the following data.

1) Rumours: These can help us know where to look in the future. This data is usually of the type: "Milt was seen around Fairmile Point near the end of March" or "Eggs seen on the beach south of Duke Point". Even "milt only" reports are useful, as they might help us understand changes in spawning behaviour that might occur as the population's age structure changes.
2) Where and When: "Eggs confirmed, Ten Mile Point, spawning March 23 – 25". Position should be as accurate as possible.
3) Beach length of spawn, or an accurate position plotted on a chart.
4) Spawn width and intensity – collected through a spawn survey.

Steps for Surveying Spawn Beds

A spawn surface survey report has two parts, a chart showing the location of spawn beds and the Herring Surface Spawn Survey Field Assessment Worksheet. The worksheet is shown on the next page.

1) Fill in the top of the Assessment Worksheet.
   a. Date of Survey: Use alphabetic abbreviations for month to avoid confusion.
   b. Start/End Time: 24 hour clock.
   c. Area: Statistical Area only. Sub-areas have never been used in herring work.
   d. Location: As specific as possible, bearing in mind that one worksheet can have records for several locations on it.
   e. Map: Assign a reference number to the chart used so that the worksheet can be matched with the appropriate field chart.
   f. Method: check all that apply.
   g. Estimated maximum vertical visibility: in metres.
   h. Secchi Depth: ignore this if you do not have a Secchi disk.

2) Starting at one end of the spawn bed, find end of spawn (EOS). Map this on the chart. If bed is big enough, place a buoy at the EOS.

3) Moving through the bed, find and map the other end of spawn. Place buoy. A bed should be relatively uniform – width and vegetation type shouldn't vary much through the bed. Assign a Spawn Segment identifier (number, letter, or combination) to the spawn bed you're working on, note it on the chart and start a record for it on the Assessment Worksheet.

4) Record Start and End dates for the spawn bed, if known or estimated from egg age as described in Appendix D.
5) Place buoys on the outer edge of the spawn at regular intervals.
6) Using the buoys, measure the spawn width and determine average width for the bed.
7) Moving through the bed, observe and make notes on vegetation types, coverage, egg layers, and bare patches (see details below). Record on the assessment sheet.
8) Move to the next spawn bed. Repeat #2 to #7.

Herring Surface Spawn Survey Field Assessment Worksheet

Date of Survey: ______________________ (yyyy/mmm/dd)   Start Time: ____________________

End Time: ____________________

Area: ________   Location: ____________________________

Map: ____

Method:

- ☐ Boat
- ☐ Other
- ☐ Viewer
- ☐ Boat
- ☐ Rake
- ☐ Snorkel

Estimated Max. Vertical Visibility (m): __________   Secchi Depth (m): __________

					Layers of Eggs / % Cover								
Spawn Seg	Date of Spawning Mon/Day	Mon/Day	Length (m)	Width (m)	GR	RW	KP	BA	LR	SR	RK	0	% Bare

What is a Spawn Bed?

One of the big differences between surface and dive survey protocols is that there are no fixed sampling intervals in surface surveys. Defining the bed is left to the discretion of the surveyor. A bed might be a few metres long or it might be tens of kilometers long. As a general principle, a surface surveyor will start a new bed record if the characteristics of the spawn changes – width or substrate being the most likely to change. In areas such as the mainland inlets it is not uncommon for spawn to be quite homogenous as the herring may spawn only on the 2 metre wide band of Fucus on either side of the inlet. In this case one record can reasonably describe the spawn over a long distance, with additional records needed only if there are discrete breaks in the spawn. In other areas the spawn bed is more complex and more records will be needed as the herring schools move from alluvial fans to rocky shores, or switch from Sargassum to eelgrass.

In the past surveyors have even recorded two beds where spawn occurred high in the Intertidal zone on rockweed and lower on eelgrass when a significant gap existed between the two vegetation bands.

It is important that the entire area of spawn be systematically observed in a manner similar to diver surveys. Working at low tide when more of the spawn is exposed to view is ideal, but surveyors will also have to rely on vegetation rakes, bathyscopes, and snorkeling to if the bed can't be inspected at low tide. The rake in particular is critical for finding the outer edge of spawn, unless one has the luxury of a drop camera.

Vegetation Types

As in dive surveys, only vegetation types that have herring eggs attached to them are recorded. Vegetation without attached eggs is ignored. Most vegetation types are coded differently between the two survey types. Differences are noted in orange in the table below.

VEGETATION CODES FOR SURFACE AND DIVER SURVEYS

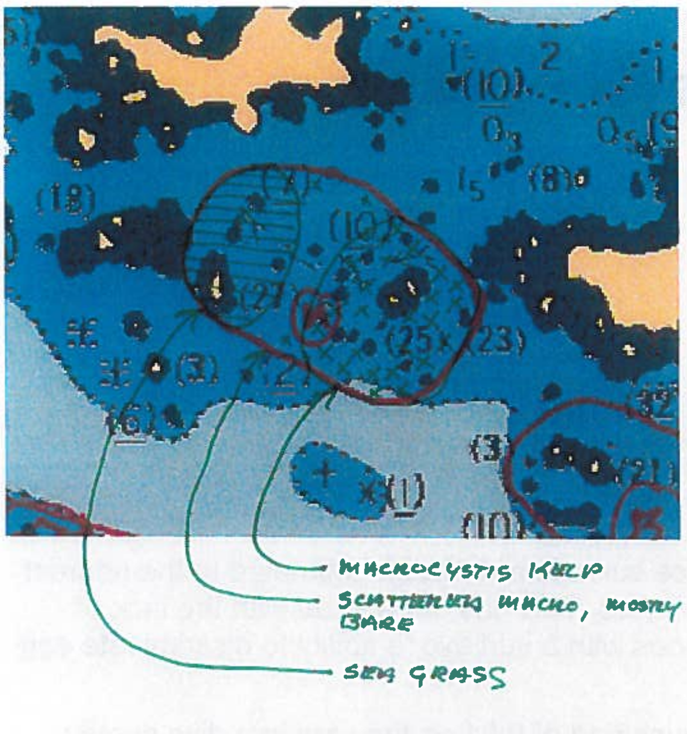
VEGETATION TYPE	CODES	
	Surface	Diver
Macrocystis	KP	Macrocystis
Grasses	GR	GR
Rockweed	RW	RW
Kelp (flat)	KP	KF
Kelp (stalked)	KP	KS
Sargassum	BA	SM
Leafy Algae	LR, BA	LA
Stringy Algae	SR	SA
Rock	RK	Bottom Substrate
Other	O	GG

Note: Historically some surface surveys used "GR" and "SG" interchangeably for sea grasses. This was standardized to "GR" during the 1990s. Macrocystis has been recorded as "BA" and "O" but should be included in "KP".

Unlike the diver survey protocol, little differentiation is made between bottom types. "Rock" includes any spawn directly on the bottom, regardless of whether it is rock outcropping, boulders, cobbles, or pebbles. The catch-all category "Other" can include shell and mud on those rare occasions where appreciable spawn occurs on them. This category can also be used for Ulva (green sea lettuce) and material which would fall under the diver's "Grunge" category, including plume worm tubes, stumps in log dumps, and garbage at dump sites.

Percent Cover and Percent Bare

Percent cover is the percentage of the spawned area covered by a particular substrate type. Only substrates with eggs attached are considered, bare areas are accounted for later under the "% Bare" column. **<u>The total % Cover of all substrate types must be 100%, % Bare is estimated later</u>.**



The chart to the left shows a spawn bed containing a dense patch of spawned Macrocystis to the east and a spawned patch of sea grass on a ledge around the islets to the west, with some scattered spawned Macrocystis plants in between. The surveyor estimates that 70% of the area covered with eggs is Macrocystis, and 30% of the area is sea grass. This is recorded on the worksheet as shown in the next diagram, under the "GR" and "KP" columns.

Herring Surface Spawn Survey Field Assessment Worksheet

Date of Survey: 2020/APR/05 (yyyy/mmm/dd) Start Time: 09:00 End Time: 18:00

Area: 25 Location: OUTER NUCHATLITZ

Map: 25-1

Method: Boat Other; Viewer; Boat; Rake; Snorkel

Estimated Max Vertical Visibility (m): 6 Secchi Depth (m):

Spawn Seg	Date of Spawning Mon/Day	Mon/Day	Length (m)	Width (m)	GR	RW	KP	BA	LR	SR	RK	O	% Bare
					Layers of Eggs / % Cover								
A	APR/01	APR/02	550	325	30		70						20
B	"	"	800	275									
C	"	"	400	300									
D	"	"	600	550									
E	"	"	700	200									

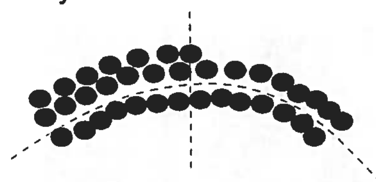
The next step is to estimate the percent of the bed without spawn. In this case, the surveyor estimates the total area without eggs within the bed (mainly the strip between the two main spawn patches) is 20%, as shown under the "% Bare" column.

Layers of Eggs

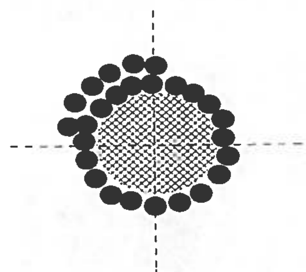
During spawning, female herring repeatedly pass over the substrate, building up the spawn into layers as they go. To estimate the number of layers, rip a ""leaf"" off a typical plant and look at it from the side or end on, so you can count the layers in cross section. If the ""leaf"" is flat, count the layers on both sides; if stringy (round), count the layers across the diameter as shown in below. The diagram below shows 2.5 layers on both types of substrates.

Egg layers are estimated in the same way as described in the dive survey protocol

Flat 'Leaf'



Round

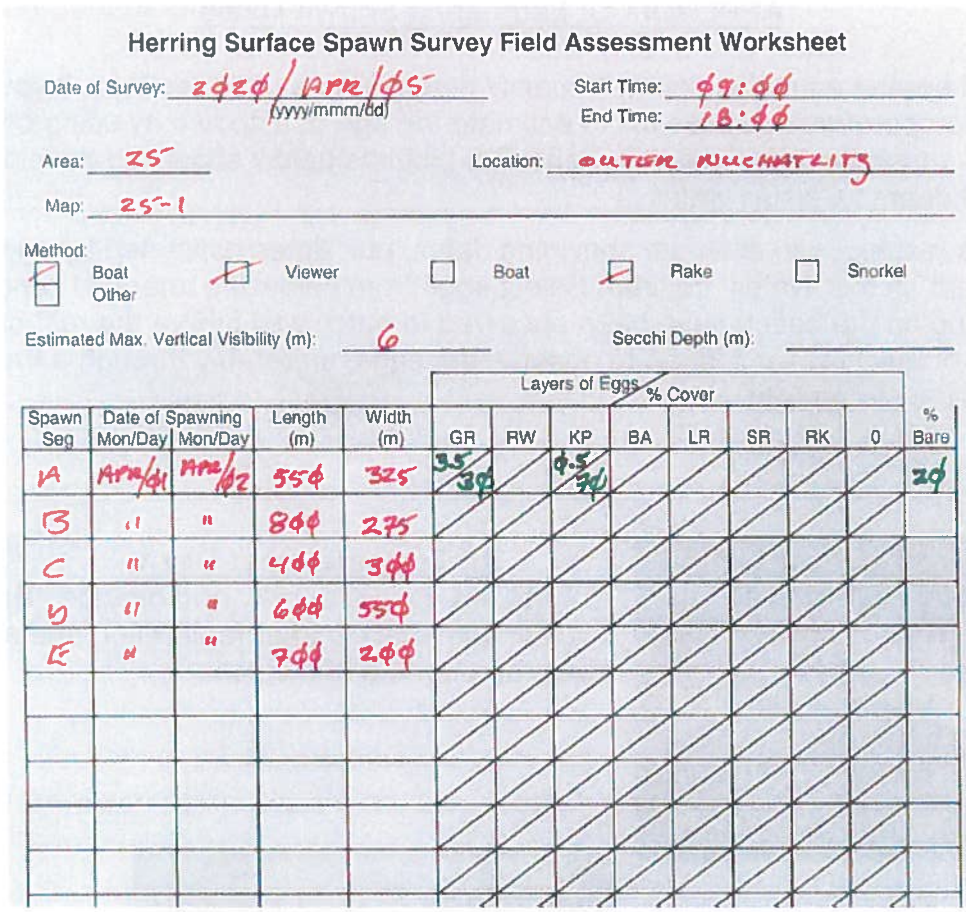


above. Traditionally, egg layers in surface surveys have been estimated to the nearest 0.1 layers, rather than the nearest 0.25 layers. This has more to do with the lack of space on surface survey forms than it does with a surveyor's ability to discriminate egg deposition down to a tenth of a layer.

Trace spawns are entered as 0.1 layers instead of 0.01 as they are in a dive survey. This does not have a significant impact on biomass calculations.

When estimating egg layers consider only the egg mat and ignore parts of the plant with no spawn. We frequently see eelgrass with a 4 to 6 layer egg mat spawned on the bottom half of the plant, and the top half of the plant bare. In this case the egg layer estimate would be 5 layers, ignoring the part of the plant without eggs.

The image below shows the complete record for the first spawn bed, assuming the survey found 3.5 layers deposited on the sea grass and half a layer on the Macrocystis.



Herring Surface Spawn Survey Field Assessment Worksheet

Date of Survey: 2020/APR/05 (yyyy/mmm/dd)

Start Time: 09:00

End Time: 18:00

Area: 25

Location: OUTER NUCHATLITZ

Map: 25-1

Method: [x] Boat / [ ] Other; [x] Viewer; [ ] Boat; [x] Rake; [ ] Snorkel

Estimated Max. Vertical Visibility (m): 6

Secchi Depth (m):

Spawn Seg	Date of Spawning Mon/Day	Date of Spawning Mon/Day	Length (m)	Width (m)	Layers of Eggs / % Cover: GR	RW	KP	BA	LR	SR	RK	0	% Bare
A	APR/01	APR/02	550	325	3.5 / 30		0.5 / 70						20
B	"	"	800	275									
C	"	"	400	300									
D	"	"	600	550									
E	"	"	700	200									

Completed Data Packages

Please return completed survey forms as soon as possible to the Pacific Biological Station, attention Charles Fort (250-756-7259, 250-616-7497) or Matthew Thompson (250-756-7082; 250-714-6004):

Pacific Biological Station
Fisheries and Oceans Canada
3190 Hammond Bay Road
Nanaimo, B.C. V9T 6N7

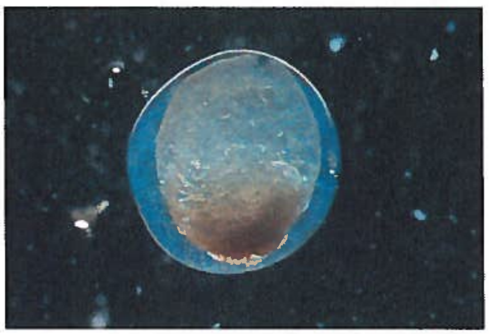
A complete data package includes:

Field Assessment Worksheets
Spawn charts

APPENDIX D: Estimating Spawn Dates

The speed herring eggs develop at is mainly determined by temperature. If you know the water temperature it is possible to estimate the age of a spawn by using certain landmarks during the eggs' development. The pictures below show egg development in 5, 7, and 9 degree Celsius water.

To use this technique to estimate spawning dates, put "dates estimated by egg development" in the "Notes" column. Select eggs from below the intertidal zone, as eggs high up on the beach have been observed to hatch well before the rest of the bed. Use a 10x or 20x jeweller's loupe to observe the eggs, preferably through a transparent surface over a strong light.

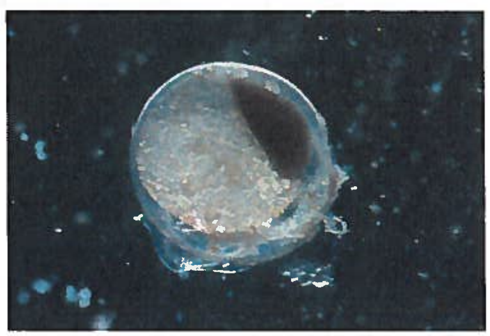


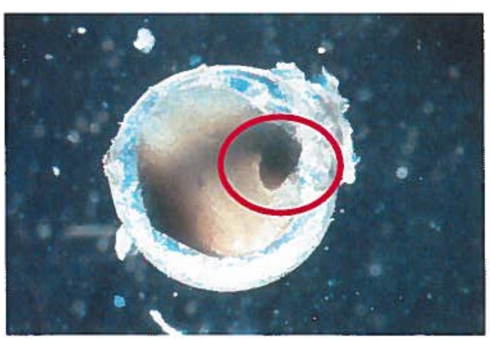
All Temperatures: Day 1

Unfertilized eggs are milky and opaque. They begin to clear immediately after fertilization and a dark cap forms on one end of the yolk.

5º - Days 2 to 5
7º - Day 2
9º - Day 2

Well developed cap on yolk.

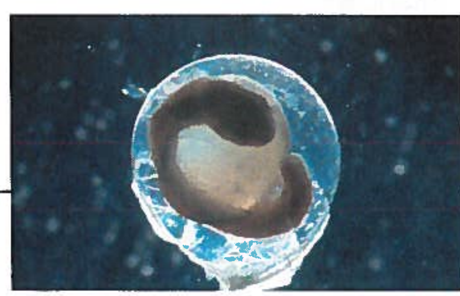




5º - Day 6
7º - Day 3
9º - Day 3

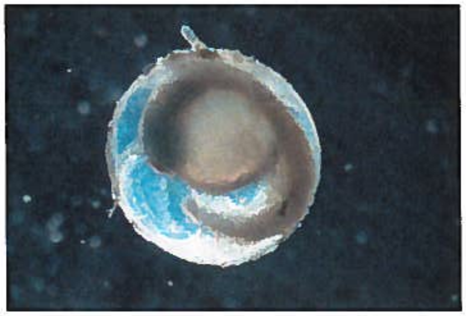
Embryo begins to form.

5º - Day 10



7º - Day 5
9º - Day 4

Tail almost touches head, end of tail has lifted off yolk.

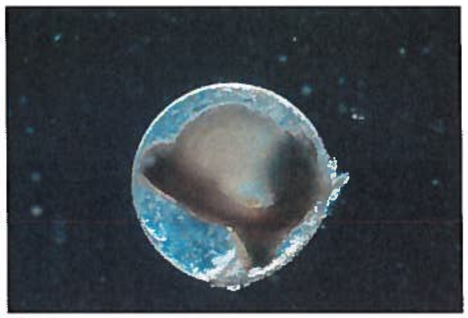


5º - Day ?
7º - Day 6
9º - Day 5

About this time the first convulsive body movements start.

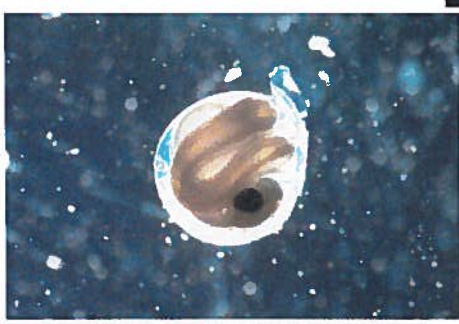
7º - Day 7 to 8
9º - Day 7

Tail well past head. Eyes pigment and become obvious.



5º - ~Day 12

develop black



5º - Day 12 to hatching
7º - Day 8 to hatching
9º - Day 7 to hatching

Tail continues to grow around yolk. Eyes turn from black to golden. Embryo becomes progressively more active, spinning rapidly in the egg case 1 to 2 days before hatching.

5º - Day 28 to ?
7º - Day 18 to 19
9º - Day 14 to 15

Hatching.

APPENDIX E: Seaweeds

Note: Colour plates refered to below are not available.

In herring-spawn surveys marine vegetation (seaweeds and sea grasses) is divided into categories based upon shape. These categories are as follows:

Code	Vegetation Type
GR	Sea grasses
RW	Rock Weeds
KF	Flat kelp
KS	Stalked kelp
SM	Sargassum
LA	Leafy algae
SA	Stringy algae
GG	Grunge

Plants are divided into these groups primarily because the number of herring eggs seaweed are covered with varies mainly with its shape (this is known as egg-packing). The following describes each of the vegetation categories used in herring-spawn surveys, and explains where you are most likely to find them. Descriptions are also presented on page 16 of the main text. Plate 1 illustrates the general form of each category.

Sea Grasses (GR) - There are two species of plants in this category, eelgrass and surf grass. **Eelgrass** (Plate 2) is more common than surfgrass. It is usually found from the lower intertidal to the shallow subtidal, growing in mud and sand. The blades of eelgrass are quite narrow, usually 3 - 10 mm (1/8 - ½½ in) wide, and may be a metre (39 ins) long. **Surfgrass** (Plate 3) grows on rocky shores in exposed areas. It has very narrow, bright green blades, usually less than 3 mm (1/8 in) and 12 - 50 cm (15 - 20 in) long. It is found from the lower intertidal to the shallow subtidal.

Rockweed (RW) - There is only one plant in this category. **Rockweed** is a brown - yellow plant, with forked branches (Plate 4). It is very common in the upper intertidal throughout the coast on rocky shores.

Flat kelp (KF) - Flat kelp, as its name suggests, lies flat on the sea floor. It is usually attached to rock by a root-like anchor called a holdfast. Flat kelps are found from the lower intertidal to the subtidal, usually in sheltered areas. Flat kelp has a single brown blade. There are many species of flat kelp one of which, called sugar kelp, is shown in Plate 5.

Stalked kelp (KS)- Stalked kelp is similar to flat kelp, but has a thick woody stalk which holds the plant upright. The stalk may be up to 2 metres (6 feet) long and is branched in one species (Plate 6). Stalked kelps have one or many blades branching from the top of the stalk. The blades are up to 1 metre (39 in) in length. Stalked kelps grow on rock, from the shallow subtidal and deeper. It is found in sheltered and exposed areas. There are several species of kelp in this category.

Macrocystis. *Macrocystis*, or giant kelp is a species of kelp (Plate 7). It is not found in the Strait of Georgia, where summer water temperatures are too high and the water is too fresh (from Fraser River run off). This plant is up to 10 m (30 feet) long. It has many stalks (called fronds or stipes) which grow from a strap-like holdfast. Blades branch from each frond at regular intervals. Each blade has a small float at its base, which causes the fronds to float upright in the water. Macrocystis often sinks when it is heavily covered with herring spawn. Because *Macrocystis* plants are big and complex, a special method, outlined in the Macrocystis section in the main text is used to estimate spawn cover.

Sargassum (SM). Sargassum, or *Japanese weed* grows on rocks from the mid-intertidal to the shallow subtidal (Plate 8). It is yellow-brown in colour and up to 2 metres (6 feet) long. It looks like a bottle brush, with bb sized gas bladders scattered throughout the tiny leaves. It is most common in the Strait of Georgia, especially around Denman and Hornby islands, but is also found on the west coast of Vancouver Island.

Leafy algae (LA) - The leafy algae category contains many species of seaweed. It is the most variable category, containing brown, green but mostly red-coloured seaweeds. Leafy algae are found from the upper-intertidal to the subtidal. Several of the more common species of **leafy algae** are shown in Plates 9-12. Sea lettuce (Plate 9) is a green leafy algae which is found in the shallow intertidal on rocky shores. Turkish bath towel algae (Plate 10) and iridescent algae (Plate 11) are examples of red leafy algae. Acid-weed (Plate 12) is an example of a brown leafy algae.

Stringy algae (SA)- Stringy algae are found from the intertidal to the subtidal. The group is almost entirely made up of red algae. All of these seaweeds have stringy branches and are reddy-brown to pink in colour. Some of the more common species are shown in Plates 13-17. Firweed or *Rhodomela* is brownish black in colour and has branchlets which spiral around the main branch (Plate 13).This plant gets its name from the branchlets which look like the needles on a fir bough. Firweed is found in the mid-lower intertidal. Several other common species include the pepper algae which is named for its taste (Plate 14). Most red algae do not have common names, *Aghardiella* (Plate 15) and *Plocamium* (Plate 16) are two common species, both are found in the subtidal. Coralline algae (Plate 17) are pink coloured algae which are coated in a calcium skeleton which gives them a crunchy texture (this hard outer skeleton stops sea urchin grazing). Sometimes herring will spawn on **worm or amphipod (sand-flea) tubes**. These are included in the stringy algae category because of their shape.

Grunge (GG). This category is self-explanatory. It is a rarely used miscellaneous group for plants or things which herring have spawned on that do not fit into any of the other categories. Tube worms, leaves, and wood, for example, are grunge.

APPENDIX F: Other Species Of Interest

Aquatic Invasive Species

Recent observations suggest that certain aquatic invasive species are expanding their range along coastal B.C., including several species of tunicates which might have an impact on herring spawning grounds. Research on these species is still at the stage of trying to determine where they are in B.C. waters, so any sighing information would be appreciated by the researchers. Spawn survey divers may are report sightings by the route given below or by notes on the transect sheets and in the survey journal. These observations will be forwarded to the interested parties.

Please report your Aquatic Invasive Species (AIS) sightings to the Department of Fisheries & Oceans Canada (DFO) at:

E-mail: **AISPacific@pac.dfo-mpo.gc.ca**

Phone: 888-356-7525

A species specialist will contact you if follow-up is requested/required.

Information Required:

AIS identified (species name)
Name of Sampler/Collector/Identifier (to remain confidential)
Date of Observation/Collection (year/month/day)
Time of Observation/Collection (24-hour clock)
Location of Observation/Collection (common name, chart reference, etc.)
Location of Observation/Collection (GPS reading with latitude and longitude recorded as degree-decimal-minutes (to three (3) decimal places)

Depth of Sample Observation/Collection (measured in metres or characterized as high, mid or low intertidal, shallow or deep subtidal, etc.)

Substrate Associated with AIS Observed/Collected (rock, sand, mud, aquaculture gear, fishing line, net pen, etc.)

Additional Information (NOT required but potentially helpful):

Reason for AIS Observation/Collection (beach combing, citizen report, provincial or federal government survey, etc.)

Water temperature
Air temperature
Tide cycle (flooding, ebbing, high, low, etc.)
Estimated abundance of AIS (scale of 1 to 3) where:

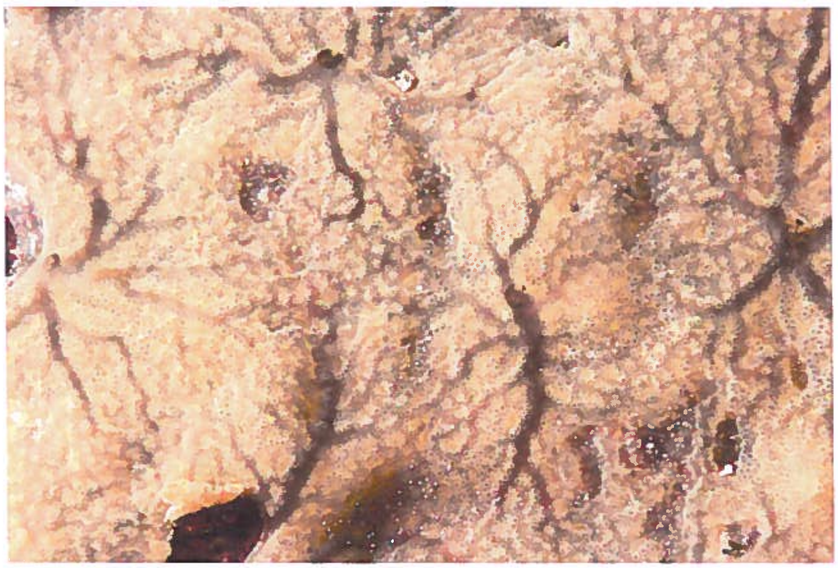
1 = sparse/uncommon/patchy
2 = relatively common/abundant/many patches
3 = very common/abundant/everywhere

Didemnum sp.

Common Name: colonial tunicate

Key Characteristics:

- Colonies range in colour tan, cream, yellow, orange or pinkish
- Lobed encrusting colonies
- Small white dots and pin-hole pores on tunicate's surface



Didemnum sp. from Agamemnon Channel
Photo credit: Bernard Hanby

Website: http://woodshole.er.usgs.gov/project-pages/stellwagen/didemnum/htm/brit4a.htm

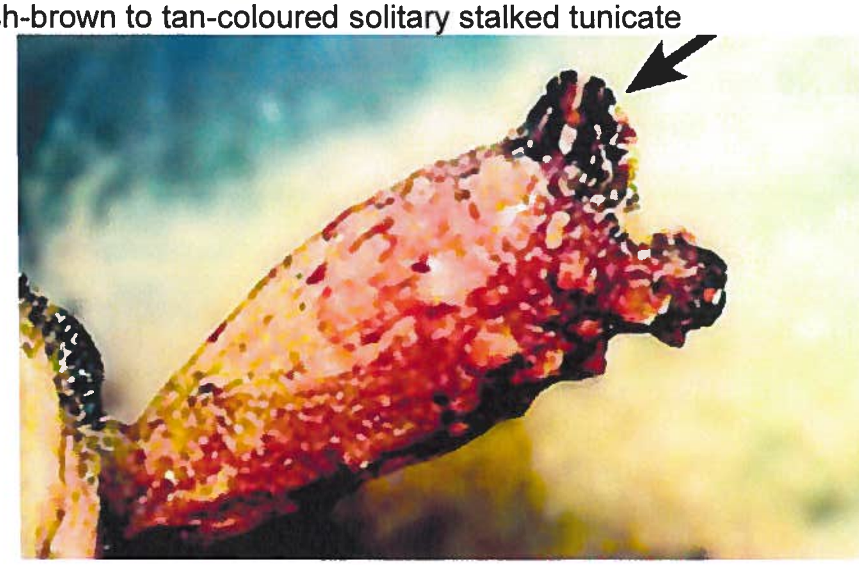
Didemnum sp. from Agamemnon Channel
Photo credit: Bernard HanbyWebsite: http://woodshole.er.usgs.gov/project-pages/stellwagen/didemnum/htm/brit4a.htm

Styela clava

Common Name: Club Tunicate

Key Characteristics:

- Long, club-shaped body, tapering to a thin stalk
- 2 large siphons
- purple strips on siphons
- reddish-brown to tan-coloured solitary stalked tunicate



Styela clava in Washington State
Photo credit: Stachowicz Lab
Website: http://www.wsg.washington.edu/research/ecohealth/tunicatecard.pdf

Styela clava
Photo Credit: Andrew Cohen
Website: http://www.exoticsguide.org/species_pages/s_clava.html

Botrylloides violaceus

Common Name: Chain Sea Squirt, Violet Tunicate

Key Characteristics:

- colonies are orange, yellow, red, purple or tan in colour. Occasionally brown or lavendar.
- Zooids arranged in loose circle, rows or dense clusters

Botrylloides violaceus from San Francisco Bay
Photo Credit: Luis A Solórzano
Website: http://www.exoticsguide.org/species_pages/b_violaceus.html

Botryllus schlosseri

Common Name: Golden Star Tunicate

Key Characteristics:

- Small zooids with white or yellow markings
- Zooids form star-like appearance
- Colonies range in colour from orange, yellow, red, white, gray-green, purple, dark gray or black
- All zooids within a colony are the same color.

Botryllus schlosseri from San Francisco Bay
Photo Credit: Luis A Solórzano
Website: http://www.exoticsguide.org/species_pages/b_schlosseri.html

Botryllus schlosseri from San Francisco Bay
Photo Credit: Andrew Cohen
Website: http://www.exoticsguide.org/species_pages/b_schlosseri.html

References/Websites

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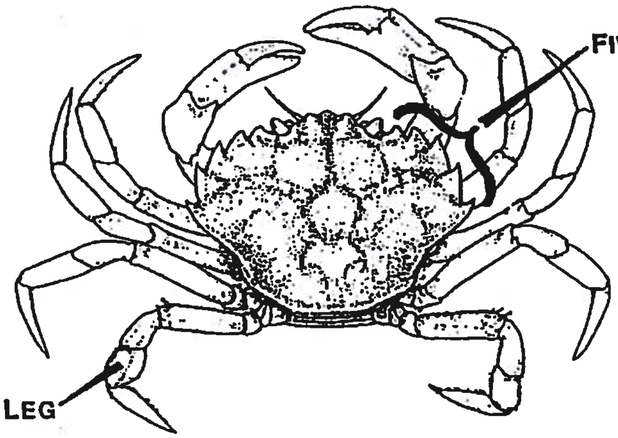
http://www.wsg.washington.edu/research/ecohealth/tunicatecard.pdf



Up to 3 inches wide across the back of the shell
Color variable, dark, mottled, often green or orange

ALERT!

Have You Seen This Crab?

The green crab, *Carcinus maenas*, is a voracious predator of clams and oysters and a potential threat to these commercial species. Although not naturally occurring in BC waters, green crab have now migrated here. In June 1999, live 60 mm (2.5 in.) male and female green crab were collected in Useless Inlet, at the head of Barkley Sound on the west coast of Vancouver Island. We need to document their range expansion and growth rates. If you see what you believe is a green crab, please collect it, freeze it, record the precise date and location found, and contact either:

Graham Gillespie
Pacific Biological Station
Fisheries and Oceans Canada
Nanaimo, B.C., V9R 5K6
Phone 250-756-7215 fax 250-756-7138

Green Sea Turtles

Two green sea turtles were found dead in Clayquot Sound in 2002. Please log any reports and the information will be passed on to the interested scientists. If dead turtles are found please note on the Cetacean Form.

Marine Mammals

Marine mammal sightings recorded in the daily journal and the Cetacean Form will be passed forward to the Marine Mammals group at the Pacific Biological Station. Observations of sick, injured, entangled, or dead marine mammals (including seals, sea lions and sea otters) should be reported as soon as possible to DFO's observer, record, report hotline at 1-800-465-4336.

APPENDIX G: Spawn Survey Equipment Inventory

DIVE SURVEY EQUIPMENT CHECKLIST

Year: **Survey #:** **Area:** **Vessel:**

Minimum Survey Equipment : Charters with support vessel running 2 skiffs (41-46) and charters with 1 skiff (47-48, 51 and DFO).

Out	In	
☐	☐	Marked lead line in draining totes, cannonball on one end:
		Haida Gwaii (41): 1 x 600
		2 x 300
		PR (42): 2 x 600
		CC (43): 2 x 300
		SG/CC (44): 2 x 300
		1 x 600
		SoG (45): 2 x 600
		SoG (46): 4 x 600
		SWCVI (47): 2 x 600
		NWCVI (48) 2 x 300
		Shorebased (51): 1 x 600
		DFO 1 x 300
☐	☐	Small tote, containing:
☐	☐	Vegetation rake with line
☐	☐	Underwater viewer
☐	☐	7 clipboards with attached Bencia pencils.
☐	☐	2 spare 5 lb. lead cannonballs.
☐	☐	Lead line repair kit: spare disks, bolt snaps, and zap straps.
☐	☐	Large tote, containing:
☐	☐	2 buoys, each with 20 metres of attached line, clip, and cannonball
☐	☐	2 spare buoys, each with either 20 metres or 2 metres of attached line and clip.
☐	☐	3 collapsible quadrats
☐	☐	Ammo Box, containing Diver Recalls:
		41, and 42: 20
		43: 10
		44, 45 and 46: 75
		47 and 48: 20
☐	☐	Deepwater rake for WCVI (47)

HERRING SPAWN SURVEY DOCUMENT CHECKLIST

Year: **Survey #:** **Area:** **Vessel:**

In Data Binder:

- ☐ Summary forms (10)
- ☐ Dividers (by Statistical Area)
- ☐ Spawn Data Entry Program DVD (SpawnDive 2010)
- ☐ USB flash drive (contains a copy of the spawn data entry program, Herring Spawn Survey Manual, Transect Charts, 2013 Dive Survey Skippers Report, template for 2013 Dive Survey Activity Log or Daily Journal, 2012 Daily Wheelhouse Logs – Seine Test and Dive Survey, and WCB regulations)
- ☐ Sardine and Cetacean Observations
- ☐ 2013 Dive Survey Skippers Report (submit to Lorena Hamer)
- ☐ 2013 Dive Survey Activity Log Template
- ☐ SDR Logs
- ☐ Herring Spawn Survey Manual DVD

In Survey Manual Binder:

- ☐ Emergency Evacuation Instructions (current year)
- ☐ Herring Spawn Survey Manual (current year)

Additional Survey Documents in Briefcase:

- ☐ Transect chart binder & charts (either 1 binder for 2 skiffs or 2 binders – 1 for each skiff).

- ☐ Transect forms: **41, 47, 48**: 200; **42**: 300; **43**: 450; **44**: 350; **45, 46**: 600; **51, DFO:** 150

- ☐ Macrocystis forms: **41**: 150; **42, 47, 48, 51**: 50; **43, 44**: 100

- ☐ Dive logs: **41, 42, 43, 44, 45, 46, 47, 48**: 120; **51, DFO**: 90

- ☐ Spawn Survey Daily Journal, unless submitting electronic document (prefer electronic version, see example 2013 Dive Survey Activity Log Template FINAL.doc on USB drive or in Data Binder)

- ☐ 4 Bencia pencils

- ☐ 4 fine-point felt-tip markers (2 red and 2 green)

- ☐ Jeweler's loupes

- ☐ "Spawning Areas of B.C. Herring" by Hay, et al. book and website CD.

- ☐ W.C.B. "Occupational Health & Safety Regulations: Industry/Activity Specific Requirements." and CD.