U.S. Fish & Wildlife Service

Entiat River Spawning Ground Survey Protocols, 2018

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On the cover: A surveyor kayaking on the Entiat River.

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Introduction

The Entiat River has been surveyed for Chinook Salmon (*Oncorhynchus tshawytscha)* spawning activity since 1962 for the spring run and since 1957 for the summer run. Chinook Salmon spawning ground surveys consist of both redd counts and carcass recoveries, and are intended to be a complete census of the primary spawning areas in the Entiat River sub-basin. In the past two decades, these surveys have progressively become more rigorous in regards to effort and areas surveyed. This document details the methods of spawning ground surveys for Chinook Salmon in the Entiat River. The United States Fish and Wildlife Service (USFWS) Mid-Columbia Fish and Wildlife Conservation Office (MCFWCO) has been conducting these surveys since 1994.

The objectives of the spawning ground surveys are to:

- Assess the quantity and distribution of redds to estimate the spawning population of spring and summer Chinook Salmon within portions of the Entiat and Mad rivers.

- Evaluate the contribution of hatchery-origin spring and summer Chinook Salmon to the spawning population, which includes documenting redd superimposition by summer Chinook Salmon on Endangered Species Act (ESA)-listed spring Chinook Salmon.

- Document the spawning occurrence of Sockeye Salmon (*O. nerka)* and Coho Salmon (*O. kisutch)* during Chinook Salmon surveys.

Historical Salmon Populations

The Entiat River has historically supported salmon runs consisting of Chinook Salmon and Coho Salmon (Craig & Suomela, 1941). In the late 19th century, numerous dams were constructed on the lower 10 river miles (RM) of the Entiat River for milling, logging and power generation (Long, 2001). These dams impeded the migration of salmon to their natal spawning grounds. By 1939 salmon were extirpated from the Entiat River (Craig & Suomela, 1941). Some mill dams on the Entiat River had fish ladders, but were ineffective in passing fish (USBF, 1934/1935/1936). From 1939 to 1943, as part of the Grand Coulee Fish Maintenance Project, late-returning adult salmon (mainly summer and fall Chinook Salmon) were trapped at Rock Island Dam and relocated to tributaries below Grand Coulee Dam including the Entiat River.

Some of the fish collected were also relocated and spawned at national fish hatcheries (NFH) in the area including: Leavenworth, Entiat, and Winthrop NFHs (Fish & Hanavan, 1948). The goal of the relocation effort was to rebuild salmon runs in mid-Columbia tributaries in an effort to mitigate for the loss of natural salmon production above Grand Coulee Dam. In 1948, the largest flood on record removed the last of the channel-spanning dams in the Entiat River and it remains undammed.

Spring Chinook Salmon

In the final years of construction of Grand Coulee Dam (1939–1941), little effort was made to re-establish natural spring Chinook Salmon runs in the Entiat River. From 1942 to 1944, the Entiat NFH used brood stock from upriver stocks collected at Rock Island Dam to rear and release a total of 1.3 million sub-yearlings and ~50,000 yearling spring Chinook Salmon (Mullan, 1987). Spring Chinook Salmon production at Entiat NFH was terminated in 1945 and re-activated in 1974. Egg sources included: Cowlitz River (1974), Carson NFH (1975–1982), Little White Salmon NFH (1976, 1978, 1979, 1981), Leavenworth NFH (1979–1981, 1994), and Winthrop NFH (1988). Adults that voluntarily returned to the hatchery were the primary broodstock in 1980 and from 1983 to 2006. The last spring Chinook Salmon juvenile release into the Entiat River was in 2007, after which the program was again terminated. No Entiat NFH spring Chinook Salmon have been observed since 2010 when the oldest age-class returned to the hatchery.

Natural-origin spring Chinook Salmon were observed spawning in the Entiat River above RM 18.4 as early as 1956 (French & Wahle, 1960). From 1962–1993, Washington Department of Fish and Wildlife (WDFW) annually walked the Entiat River after peak spawning between RM 21.3–28.1 (reaches 1–3, also referred to in past reports as the *index* area; Figure 1), to count spring Chinook Salmon redds. In 1994, MCFWCO assumed responsibility for monitoring spring Chinook Salmon redds in the Enitat River. At that time MCFWCO also expanded the survey area so that additional known downstream spawning reaches were included (below the *index* area), from RM 16.2–21.3 (referred to as the *expanded* section in prior reports) and based on indications of limited but consistent spawning activity a section on the Mad River, from RM 1.5–3.5.

Summer Chinook Salmon

Summer Chinook Salmon are not considered endemic to the Entiat River sub-basin, however several efforts have been made to establish them following completion of Grand Coulee Dam (Craig & Suomela, 1941). In 1939 and 1940, a total of 3,015 adult summer Chinook Salmon, collected at Rock Island Dam from mixed upriver stocks, were placed in upper Entiat River spawning areas, and only an estimated 1,308 of these survived to spawn (Fish & Hanavan, 1948). The Entiat NFH, in addition to other species and stocks, reared and released juvenile summer Chinook Salmon into the Entiat River from 1941–1964, and in 1976 (Mullan, 1987). After termination of the spring Chinook Salmon program at Entiat NFH in 2007, the summer Chinook Salmon program was reinitiated in 2009 and the first juvenile release occurred in 2011. The Entiat NFH summer Chinook Salmon egg sources have included mixed upriver stocks intercepted at Rock Island Dam (1939–1943), Methow River (1944), Carson NFH (1944), Entiat River (1946–1964), Spring Creek NFH (1964), and Wells Hatchery (1974, 2009–2013). Adult summer Chinook Salmon returning to Entiat NFH have been the primary brood source since 2014.

From 1957 to 1991, the Chelan County Public Utility District (PUD) conducted aerial surveys to monitor summer Chinook Salmon spawning in the lower 10.1 RM. No summer Chinook Salmon spawning surveys were conducted in the lower section in 1992 and 1993. In 1994, MCFWCO began surveying redds on foot in the upper river (Upper River Section RM 10.1–17.5) and portions of the lower river, which included spot checks at the confluence of the Mad River (RM 10.1) and various sections below the hatchery (< RM 6.8). In 2006, MCFWCO began using rafts for annual surveys for a continuous stretch of the downstream portion of the Entiat River starting at the hatchery and concluding at the influence of the Columbia River (RM 0.3–6.8).

Sockeye and Coho Salmon

Sockeye Salmon are not indigenous to the Entiat River and were stocked on two occasions (1943 and 1944) from Lake Quinault and Lake Whatcom stocks (Craig and Suomela, 1941; Mullan, 1986). A small run of Sockeye Salmon became established in the Entiat River enabling the Entiat NFH to collect Sockeye Salmon from 1944 to 1963 and distribute juveniles outside of the Entiat

River watershed (Mullan, 1986). The Sockeye Salmon population in the Entiat River is a mix of both natural-origin and out-of-basin hatchery strays.

Coho Salmon runs were largely extirpated in the mid-Columbia River basin prior to 1941 (Mullan, 1983). Propagation of Coho Salmon at the federal mid-Columbia hatcheries began in the 1940s and extended into the early 1970s. Chelan and Douglas County PUDs, in cooperation with WDFW, started propagation of Coho Salmon in the 1970s and continued until 1994. In 1996, the Yakama Nation initiated the Mid-Columbia Coho Restoration Program, which is reintroducing the species into the Wenatchee and Methow sub-basins. Although no Coho Salmon have been released in the Entiat River, Coho Salmon have been observed in the Entiat River since 2001.

Entiat River

The Entiat River sub-basin is located in Chelan County, in north-central Washington State (Figure 1). The river originates in a glaciated sub-basin of the Cascade Mountains and flows approximately 43 RM to join the Columbia River at RM 483 (Mullan et al., 1992). Peak discharge occurs during spring run-off, the highest flow recorded (1957–2015) was 6,430 cfs on June 10, 1972 (USGS gauge # 12452800, Entiat River near Ardenvoir, WA). The low-flow period occurs from August through March with mean daily flows of 133 cfs (1957–2015) and a record low flow of 22 cfs on November 25, 1994 (USGS gauge # 12452800, Entiat River near Ardenvoir, WA.) Sporadic weather events during this period may temporarily increase flows. The two major tributaries of the Entiat River are the Mad River and the North Fork which enter the Entiat River at RM 10.1 and 34.0, respectively. The present upstream limit of anadromy is Entiat Falls (RM 33.8). River miles are measured from the confluence of the Entiat River with the Columbia River (RM 0).

The Entiat River sub-basin drains an area of approximately 259 mi^2. The watershed is 68 mi in length and varies in width from 5–14 mi. The highest elevation in the sub-basin is Mt. Fernow at 9,249 ft and the lowest is the confluence with the Columbia River at approximately 700 ft (USDA, 1979). Fish migrating to the Entiat River travel through eight main-stem Columbia River hydroelectric dams including; Bonneville, The Dalles, John Day, McNary, Priest Rapids, Wanapum, Rock Island, and Rocky Reach dams.

Chinook Salmon spawning ground surveys on the Entiat River include most of the known available spawning habitat. No surveys were conducted between the downstream end of reach 5 (RM 16.2) and the Entiat NFH (RM 6.8). The stretch of river between RM 6.8–16.2 has been periodically surveyed since 1994 and very few redds were detected. The valley segment not surveyed has a steeper slope, faster currents and larger substrate than the surveyed regions (Godaire et al., 2010). The two runs of Chinook Salmon overlap in some of their spawning habitat and in other areas their spawning habitat is segregated. In the upstream section, reaches 1– 5 (RM 16.2–28.1; Table 1), both spring and summer Chinook Salmon spawning habitat is available. Only spring Chinook Salmon are known to spawn in the Mad River survey reach (RM 1.5–3.5). Only summer Chinook Salmon are known to spawn in the downstream section, reaches L1 and L2 (RM 0.3–6.8).

Figure 1. Map of the Entiat River sub-basin and the spawning ground survey reaches. The beginning and end of all surveyed reaches are marked with black dots and associated river mile (RM). The survey reaches are located between the black dots and labeled 1–5, L1, L2, and MR. Main-stem Columbia River dams are represented by black squares on the Washington State outline map (WA).

Table 1. Beginning and end landmarks, mile markers, river miles and walking distances for the Entiat River and Mad River spawning ground surveys.

River	Reach	Beginning Road Landmark (Mile Marker)	End (Road and River Landmarks)	River Miles	Walking Distance (Miles)
Entiat	1	Fox Creek Campground (1.5 miles past MM 25)	Forest Service Sign (road) End of island, rebar near shore (river)	25.8-28.1	2.3
	2	Forest Service Sign (Just before MM 25)	Brief Bridge	23.4-25.8	2.4
	3	Brief Bridge (MM 22)	Riverwood Sign (road) Bridge and pit arrays (river)	21.3-23.4	2.1
	4	Riverwood Sign (Past MM 19)	Guardrail and tall orange marker (road) Bend in river after the two channels rejoin, right after wooden fence (river)	18.7-21.3	2.6
	5	Guardrail and tall orange marker (Just past MM 17)	Two driveways past the brown milk truck, between MM 15 & 16 (road) Jack's Hole/McKenzie Diversion Dam (river)	16.2-18.7	2.5
	Lower 1	Entiat National Fish Hatchery (MM 6)	Fire Station	3.1-6.8	3.7
	Lower 2	Fire Station (MM 3)	Kiosk, near mouth of river	0.4-3.1	2.7
Mad		Pine Flats Campground	Pullout after the large pullout (road) House sized boulder (river)	1.5-3.5	2.0

Redd Survey Field Methods

The following section describes the field methods used to collect salmon redd data. Consistency of data collection between surveyors and between years is vital for accuracy, precision, and annual data comparisons. This section also addresses safety concerns on the river.

Defining Redds

Female salmon dig redds in the river substrate, where they deposit eggs that are fertilized by one or more males (Burner, 1951; Gallagher et al., 2007). The female will continue to dig and cover up the fertilized eggs with gravel as she lays more eggs, creating a pit and a tailspill (Figure 2). Salmon redds need a continuous supply of flowing water, so they are typically built at the head of a riffle or the tail of a pool. A redd is generally elliptical or tear-drop shaped and takes on a "shiny" or clean appearance, as there is no periphyton or fine sediments on the rocks in the pit or tailspill (Heindl, 1989).

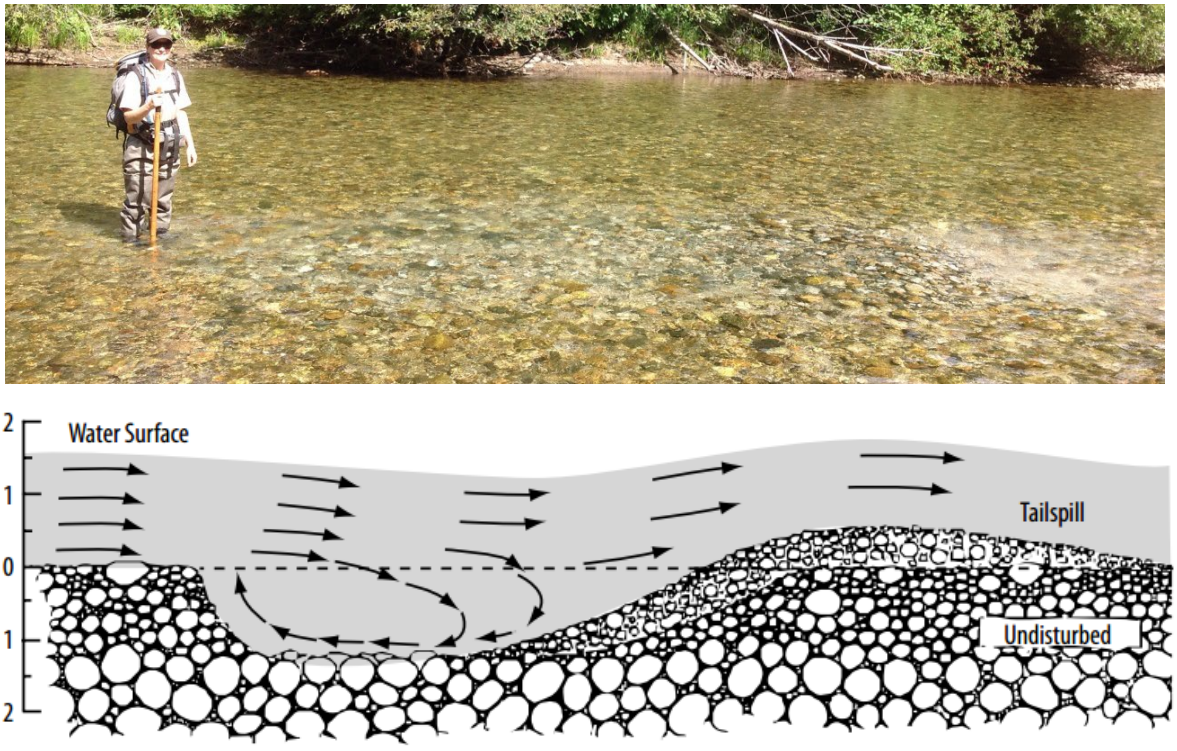

Figure 2. In the top image, a surveyor is standing at the head of the redd and the tailspill is a mound at the end of the redd (right side of image). Notice the differences in color between the redd and the undisturbed river substrate. The bottom image shows typical currents in a salmon redd (Illustration: Burner, 1951).

For spring and summer Chinook Salmon, redds are found in river substrate of small, medium, and large sized gravel, with a disturbance area larger than 1.5 m length and 0.5 m width, and have a distinguishable pit and tailspill area (Burner, 1951). Spring Chinook Salmon redds in the Entiat River are generally 4 m x 3 m and summer Chinook Salmon redds tend to be larger and have been up to 9 m x 7 m in size. When assessing if a disturbance in the gravel is a redd, multiple factors must be taken into account because some hydraulic features within the river can look like a redd. In the list below, the first three features are *key identifiers* for a redd, and the others features are additional characteristics:

1) A defined pit and tailspill
2) A live female digging with an abraided tail
3) Cut edges of the gravel along the pit and riverbed
4) Clean rocks- is one side of the rock darker due to the presence of periphyton?
5) Loose rocks within pit and tailspill (poke at the redd with your wading stick, is it loose, or embedded?)
6) There should not be any sand or silt in the tailspill when poked

Sockeye Salmon redds are frequently seen on the Entiat River. These redds are determined by the presence of live adults and are smaller than 1.5 m length and 0.5 m width and are found in substrate predominately composed of small to medium sized gravel (Burner, 1951; Quinn et al., 1995).

Redd Survey Protocols

Redd surveys are conducted annually from late-July through early-November on the Entiat River to document abundance of redds. Redd data is then used to estimate the size of the spawning population in the Entiat River (Fraser & Hamstreet, 2016). A minimum of two surveyors are required to meet safety standards and are known to dramatically improve redd observer efficiency to adequately scan both sides of the river. Surveys are conducted weekly on foot or from inflatable kayaks/pontoon catarafts (depending on location or flow), from the top (upstream) to the bottom (downstream) of the reach. Data collected on daily surveys include:

environmental data, redd observation and measurements, live fish observation, and carcass bio-sampling. Every attempt is made to complete the survey in one day.

Surveyors should wear layered clothing appropriate for the anticipated weather, waders (or shorts in hot weather), wading boots, polarized sunglasses, a watch, and a sun blocking hat. USFWS logos need to be worn and visible on each surveyor while on the river. Backpacks or survey vests should contain sampling equipment, extra layers, food, water and a first aid kit. A decimeter-graduated wading stick (1.25 inch diameter wood dowel, 1 to 1.5 meters long) should be carried for balance and doubles as a scale for measurements. Generally, a single vehicle is used to transport the crew and the equipment to the start of the reach, and a bicycle is used to shuttle from the end (bottom) of the reach back to the vehicle. A helmet and bike lock are required during a bicycle shuttle.

Historically, redd data were collected using a rite-in-the-rain paper data book, flagging on trees marking redds, a GPS unit and a camera. In 2016, the use of a tablet computer was fully implemented; each redd was marked on satellite images using the GIS Pro App by Garafa on an iPad ®.

River Flows

River flows are highly variable throughout the survey season. Flows are affected by temperature, precipitation, and snowmelt. Excessive rain causes pulses that can lead to carcasses being flushed down the river and high flows can make river crossings very challenging. Before each survey, check the flows of the river. There are multiple flow gauges on the Entiat River, and the one located near Ardenvoir, WA is the most useful for the spawning ground surveys:

https://waterdata.usgs.gov/usa/nwis/uv?12452800

When the Entiat River is above 350 cfs at Ardenvoir, surveying on foot is challenging for the lighter/smaller individuals. When flows are above 300 cfs, the use of inflatable kayaks or catarafts is highly recommended.

When kayaking or catarafting, surveyors must wear USFWS approved life jackets that are the color of safety orange and have a minimum of 200 cm^2 reflective material. Each kayak must have a throwbag easily accessible and within reach of the paddler. One spare paddle must be brought with for every two kayaks. Every kayaker must take a USFWS approved swiftwater awareness training course.

Each surveyor is assigned a side of the river to survey. When surveying from a kayak or cataraft, stay as close to the bank as possible. Staying close to the banks allow maximum survey coverage for carcass recovery potential (discussed in greater detail below), as well as redd observation near the banks. While using inflatable kayaks, kneel as much as possible to obtain a higher visual perspective on the river. Frequently step out of the kayak/cataraft onto the bank to survey redds from higher ground, especially in areas known to have redds.

Please carry kayaks/catarafts across pavement, do not drag them. When transporting the kayaks/catarafts, make sure they are clean of dirt, sand, silt, and fish remains. At the end of the season, thoroughly clean kayaks/catarafts with 303 Aerospace Protectant.

Data Collection and Transfer with the iPad

The following section describes how to set up and utilize a tablet computer to collect, store, and transfer data from the field to the office. Currently, the MCFWCO utilizes the iPad® Air2 32GB Wi-Fi + Cellular. The iPad is a touch screen tablet PC that can run Global Information System (GIS) software that allows field surveyors to accurately document redd location and the associated metadata/attributes (observers, photo, size, fish presence, etc.).

The iPad needs to have cellular capabilities, as the GPS is in the cellular hardware, but no cellular plan is needed. The MCFWCO currently uses the GISPro App by Garafa® ($300) due to the ease of use, its offline capabilities and custom data template configurations. A Waterproof case + strap (Lifeproof®) and an external battery for emergency field charging are necessary accessories for the field.

NOTE: Garafa is continuously making improvements and updating the GISPro app. The following directions may not contain every single step of the process, due to the updates.

Field Season Preparations in the Office

To begin, download the GISPro App by Garafa® onto your iPad through the MCFWCO iTunes account (wireless internet is needed). Multiple devices (iPads, iPhones) can be used under the same iTunes account. For the tech savvy, the GISPro App is user friendly and easy to navigate. You can begin with the instruction on how to download the basemaps (Appendix A), or begin with the following tutorials and information:

http://giskit.garafa.com/groups/gisprogiskitforiphoneipad/

http://gis.garafa.com/GISPro_%26_GIS_Kit/GIS_Pro_%26_GIS_Kit_-_Tutorials.html

Basemaps must be downloaded and cached for each project (wireless internet is needed). You cannot use the app effectively in the field without basemaps. Do this step first. Appendix A contains step by step instructions on how to do this.

Before heading out into the field, create points to mark each redd and carcass (wireless internet not required for this step). Points are created for both spring and summer Chinook Salmon, for every reach. Detailed instructions for setting up points and data templates are in Appendix A.

Field Methods for Surveys

A general field schedule will be created before the beginning of the week, indicating the surveyors and the reaches to be surveyed (Table 1). We try to survey every Entait reach each week, depending on weather and river conditions. The Mad River will be surveyed as time and surveyors allow.

Before each survey, sign out on the board in building two: date, names of surveyors, name of reach, inReach unit, vehicle, mode of survey (walking/kayak/cataraft), and who the office contact person is for the day. Gather supplies (see Spawning Ground Survey Gear List). Before

leaving the office, double check that the iPad and inReach are fully charged. If a battery is low, you can charge it while driving.

Once on the river, at the beginning of each survey, fill out the header datasheet in your field notebook with a pencil (Table 2). Start at the beginning (upstream) of the reach and position one surveyor on each bank as often as possible, looking for redds and carcasses. Walk along the bank or in the water as river conditions allow. For crossing the river, use good judgement: cross in areas of slower flows, good footing, and appropriate depth (surveyor height dependent). If you start crossing the river and the current is stronger than expected, or too deep, turn around and go back to the bank you came from. No river crossing (or redd, or carcass) is worth injury, hypothermia, or death.

Table 2. Spawning Ground Survey header datasheet in the field notebook.

Spawning Ground Survey - To be used with the GISPro App on iPad
Date___/___/20____ **River**_____ **Reach**_____
Species SCS SUS _____ R**edd count total for reach: _____**
Start Time_____:_____ **End Time**_____:_____
Start Temp _____ºC **End Temp** _____ºC
H2O Visibility: Good Poor
Weather: Clear Pt. Cloudy Overcast Rain
Surveyors _____
Notes:

New Redds

When looking for new redds, continuously scan the river for pits/tails of redds, "shiny" patches of gravel, and live fish. These are all indicators that a redd is potentially present. Examine the potential redd further to determine if it contains the key features of a redd. DO NOT STEP IN OR ON THE REDD!!

To record a new redd on the iPad, tap the "crosshair" sign on the upper left corner of the basemap to locate your GPS position on the river (Figure 3, red circle). Tap the "plus" sign to

add a new point to the basemap (Figure 3, green arrow). From the dropdown menu, select the proper reach and run point. Use your fingers to "pinch-and-zoom" to the highest zoom as allowed. Use one finger to adjust the basemap left/right/up/down to accurately place the point in the river. It works well to mentally split the river, both the real river and the river on the basemap, into thirds for river right, river left and center to help place the point. Select "place" (Figure 3, green rectangle) to place the point at the crosshair (center of screen). You can always edit the point's location at a later date. Once the point is placed, the point will automatically be named and numbered (ie. SCS16R3R034).

Figure 3. To mark a redd on the map, tap the "crosshair" symbol (red circle) to locate yourself on the river, tap the "plus" sign (green arrow) to add a point and tap "place" (green rectangle) when the crosshairs are appropriately located on the river for the redd location.

As of 2018, the Bing basemap had the highest resolution of the Entiat River. Since the map is not a real-time image, the basemap may not reflect what the actual river looks like. For example, a new channel was cut at the end of Reach 4 between the 2015 and 2016 field seasons, and this change has not been reflected on the basemap. In addition, the river height will differ at different parts of the year, which will not be reflected in the basemap. However, the fixed geographic features are unlikely to change year after year (houses, large boulders, large cobble beaches), and can be used for guidance in placing the points to mark redds.

Collect the following data and record in the data template on the iPad (Figure 4):

Length – measure from the top edge of the redd to the end of the tailspill, parallel to the stream flow, in meters to the nearest 0.5 m with the wading stick.

Width – measure the widest portion of the pit, perpendicular to the stream flow, in meters to the nearest 0.5 m with the wading stick.

Location – record the location of the redd in the river (right bank, center, left bank) and any distinguishable bank features (ie. above riffle, below root wad, next to cottonwood tree).

No. of Fish – record the number of fish on the redd, if there is active digging, and sex of fish if possible, including jacks (smaller, younger male fish). Record the number of fish swimming around that are not on a specific redd.

Photos – Collect one or more photo of each redd for visual documentation. One surveyor stands at the head of the redd and the photo needs to contain numerous bank features to relocate the redd at a later date (for future growth comparison and superimposition assessment). To take the photo, scroll down on the left column, tap "take new photo", tap the shutter button, and then tap "use photo" when satisfied with the image.

Superimposition – Determine if a summer Chinook Salmon redd was created on top of a spring Chinook Salmon redd. Record which spring Chinook Salmon redd the summer Chinook Salmon redd is superimposed upon (see Superimposition section for more details).

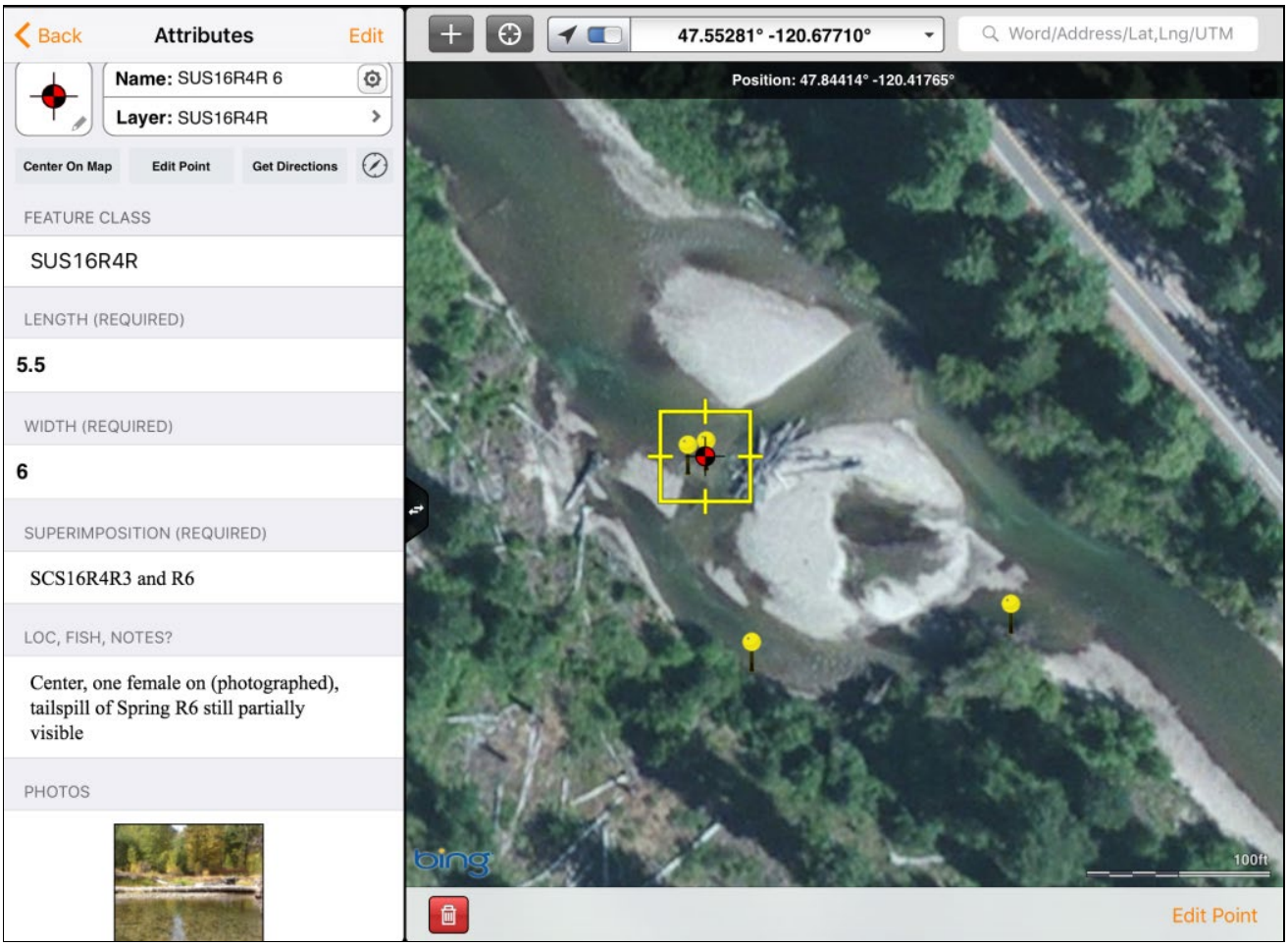

Figure 4. This screenshot shows the data template created to collect redd data during the spawning ground survey.

Test Redd

Test redds are redds that are under construction or incomplete. They will either develop into a large, complete redd or be abandoned. In the field, test redds are defined as being less than 1 m by 1 m in size (Table 3).

Table 3. Summary characteristics of test redds and new redds.

Type	**Size**	**Redd Characteristics**	**Fish Presence**	**Changes from previous survey**
Test redd	>1 m x 1 m	Shallow pit, short tailspill	No fish	Not present or no change
Redd	<1.5 m x 1 m	Defined pit with cut edges, longer tailspill	Female w/ abraded tail	Increased size

If there is an active female digging on the test redd, mark it as a new redd. If there are no live fish on the redd, mark it as a test (you can make a new feature class if it hasn't been created already). On the next survey, check the test redd. If it has grown in size or if there are any live fish on, mark it as a redd. If it stayed the same size and no fish are present, leave it as a test redd in the iPad. Once the test redd fades and is no longer visible, you can delete it from the iPad.

Monitor Marked Redds

As you continue to survey each reach week after week, monitor the redds that have already been marked. Note the count of live fish on the redd, as well as any redd size changes. From the basemap, tap the point and update the notes section, making sure to record the date next to the updated notes. Monitoring previously marked redds helps to increase observer efficiency and to determine superimposition later in the season. Unlike some other agencies that conduct spawning ground surveys, USFWS does not record redd life.

Superimposition

During summer Chinook Salmon surveys, superimposition upon spring Chinook Salmon redds needs to be determined as part of the Entiat NFH permit conditions. When encountering a new summer Chinook Salmon redd, pull up the basemap with the spring Chinook Salmon data. If a spring Chinook Salmon redd is nearby, use the photos to re-locate the spring Chinook Salmon redd. If the summer Chinook Salmon redd is superimposed anywhere on the spring Chinook Salmon redd, record which spring Chinook Salmon redd the summer Chinook Salmon redd is super imposed upon. As of 2018, we do not determine the extent of superimposition (ie 25%, 100%, etc.). The following photos give you an idea of using the photo recall function (Figure 5). The top image contains two spring Chinook Salmon redds. The bottom image contains a summer Chinook Salmon redd. By lining up bank features, can you tell if the summer Chinook Salmon redd is superimposed upon one or both of the spring Chinook Salmon redds? These photos should also give you an idea of the importance of capturing bank features in the photo to relocate the now faded redd.

Figure 5. The top image contains two spring Chinook Salmon redds, with the surveyor standing at the head of one redd. The bottom image contains one summer Chinook Salmon redd, with the surveyor located at the head.

Survey Completion

At the end of every survey, fill out the remaining header data in the field notebook (Table 2) and send out an inReach message while still in the field (see Communication Section for additional details).

Backing up the Data - In the Office

Back at the office, back up the day's survey data before going home. Don't worry, it is quick and easy!

Plug the iPad into a computer that has iTunes installed. On the iPad, return to the project's main screen and select "layers", then select the reach you just surveyed. Tap the right facing arrow to export the data (Figure 6, green square). There are multiple formats you can export the data in. KMZ is useful for ArcGIS, GPX goes to handheld GPS devices, CSV is Excel friendly for all the entered data and GPS points, Shapefile is good for ArcGIS. For backing up the data, select "Shapefile with Images". This is the only option that transfers the photos for each redd. Select "iTunes" for the quickest mode of export. You can also airdrop or email the data.

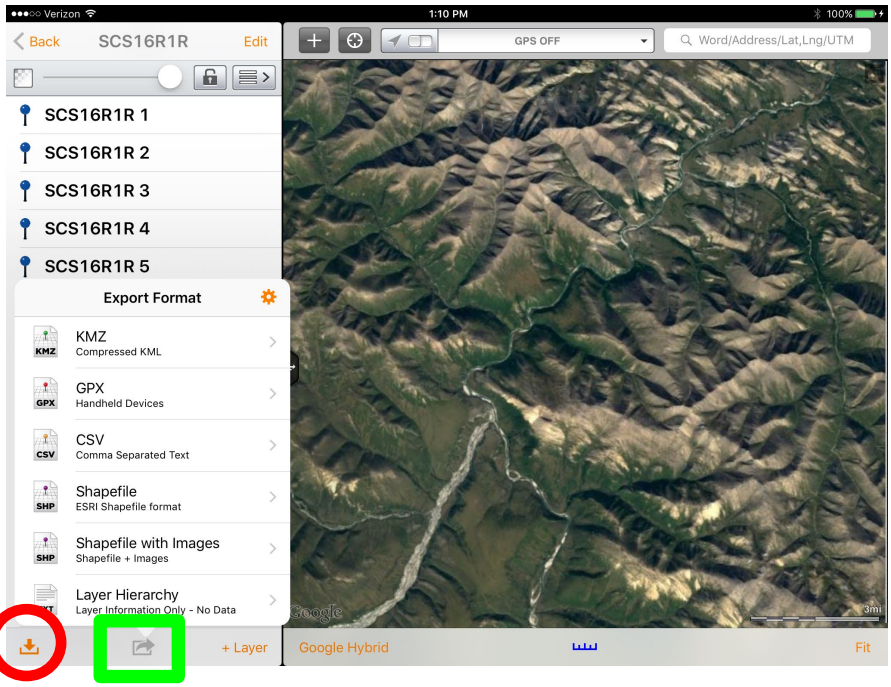

Figure 6. To export the data, select the right facing arrow (green square) and select "Shapefile with Images" for backing up the data with photos. The down arrow (red circle) allows data to be imported into the app.

Once the data is exported (which may take a few minutes if there are a lot of photos), go to iTunes to retrieve the data. In iTunes, select the iPad icon in the upper left corner (Figure 7, red circle). Click on “Apps” (Figure 7, purple rectangle). On the right side of the screen, scroll down to the bottom to File Sharing. Select the GIS icon (Figure 7, orange rectangle). Under the GIS Documents column select the file you just exported, and from here you can click and drag the file to the folder of your choice on the desktop or the common drive. Once the data has transferred to the desktop, you can delete the iTunes file (delete button or backspace button); this will not affect the data on the iPad.

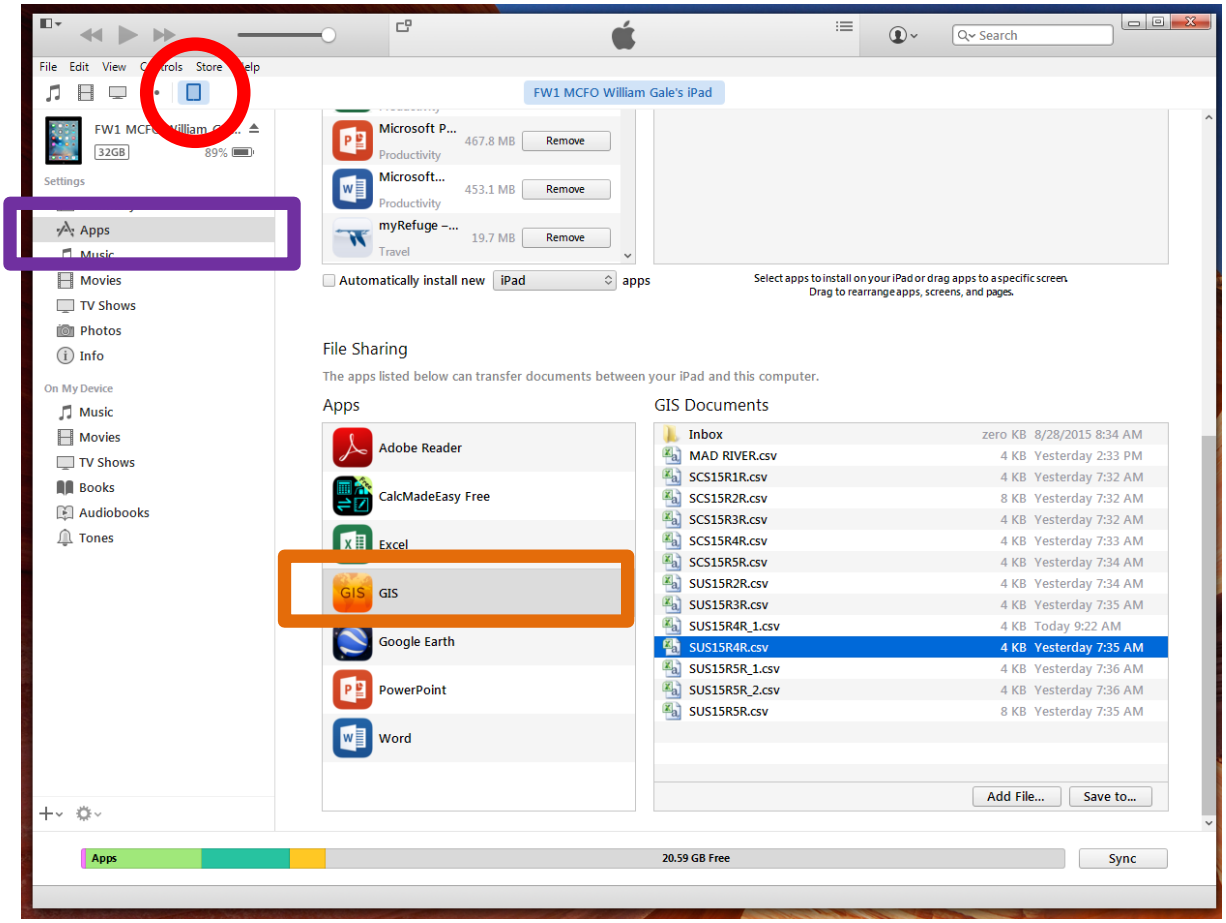

Figure 7. To retrieve the exported data in iTunes, select the iPad symbol (red circle), tap Apps (purple rectangle), tap the GIS icon (orange rectangle) and then click the file you want to drag and drop into your preferred location on your desktop or the common drive.

To transfer files from the computer to the iPad for the GISPro app, you can drag and drop your desired file into the iTunes GIS Document box. From there, go to the iPad and open the layer you want to import the data into. Select the import button (Figure 6, red circle) and then select the file you want to import.

Creating a CSV file for Easy Data Compilation

An iPad is needed to easily create a CSV file for the data that has been collected. The data that has been backed up in the office is stored in a different format (shapefile) and it is time consuming to extract the carcass and redd data from this format. If the main field iPad is available, follow the steps for backing up the data (Figure 6) and select "CSV" as the Export Format.

If the main iPad is in the field, grab another iPad with the GISPro App installed and with spawning ground data templates created. From the back-up files, select the folders (reach, carcasses, redds) and drag and drop those folders into the GIS Documents box of iTunes (Figure 7). From the iPad, import the folders to the appropriate layer (Figure 6). Once the data is imported into the iPad, select the export icon for the reach/carcasses/redds you would like, select CSV, select iTunes, and then drag and drop the new CSV file into your desired location.

Carcass Survey Protocol

Carcass recoveries are performed simultaneously with redd surveys and are used to describe the characteristics of the spawning population, including sex ratios, age class composition, and hatchery/wild composition (Fraser & Hamstreet, 2016). Data collected from Chinook Salmon carcasses include length measurements, sex, spawn success (females only), external markings, PIT tags, coded wire tags, scales, and genetic samples.

Carcass Recoveries

Starting at the beginning of the reach, look for fish carcasses of any type and any condition. The majority of the carcasses you recover will be Chinook Salmon, but you may come across Sockeye Salmon or Coho Salmon. If you encounter carcasses of other species such as Bull Trout, Mountain White Fish, suckers, and sculpin, make note of the number, location and condition of carcass. Report all Bull Trout carcass encounters immediately to the Native Fish Program and do not disturb the carcass.

As you find salmon carcasses, stop at the next convenient, comfortable, house free shore to work them up. If there are only a few carcasses, stop and work them up individually. During peak carcass recoveries, you can carry the carcasses (with a stringer, piece of willow, or in your boat) to batch them for efficiency. However, travel no more than 0.25 mile (approximate the distance). This helps keep the nutrients localized to where the fish expired and prevents the build-up carcasses in one location in the river after working them up. In July 2017, USFWS began to record GPS coordinates for recovered carcasses and the carcass survey form had been created electronically in the GISPro app.

To begin sampling a carcass, the old method (now the back-up method) was to fill out the top of the Carcass Survey Form (Figure 8), recording only *one speciesor run per card*. Fill out the date, the reach number, the scale card number that is directly associated with that data sheet, the samplers, and circle the species. The new and current method is to record carcass data on the iPad, using the same methodology as the redds, but using carcass points specific to reach and run.

Carcass Survey Form Scale Card no. _____

Date____/____/20___ Reach_____

Sampler(s)_____ Species SCS SUS SOC COS OTHER_____

	Lgth Fork	Lgth POH	PIT Y/N	Adipose Presence	Snout ID Tag	Gen ID#	Spawn Success	Sex	Lab			
									CWT	Origin	Age	FWR
1				Y P N U			C I P U			H W		
2				Y P N U			C I P U			H W		

Figure 8. Carcass Survey Form for Entiat River carcass recoveries (old method). Record only one species per card.

Collect the following data and record on the Carcass Survey Form or in the iPad. Carcass measurements and scales are generally taken with the fish laying with its head on the left and the tail on the right (Figure 9).

Figure 9. Batching salmon carcasses for sampling efficiency. Do not carry carcasses more than 0.25 mile for batching.

Lgth Fork – Fork length (Figure 10), taken from the snout to the fork of the tail, measured in centimeters.

Lgth POH – Post-orbit of eye to hypural plate (POH; Figure 10), taken from behind the eye to the point in tail where it will not bend; last vertebrae are fused to support caudal rays, measured in centimeters.

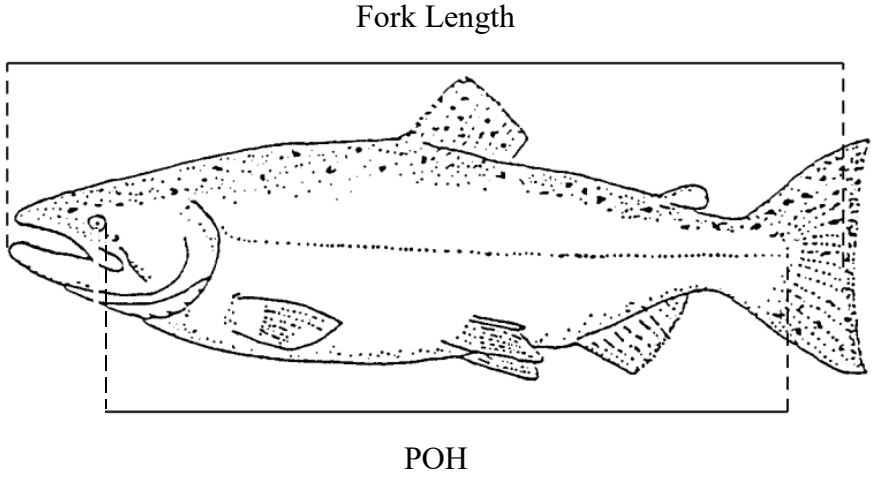

Figure 10. Fork length and post-orbit of eye to hypural plate (POH) measurement locations (Heindl, 1989).

PIT Y/N – Scan the fish's abdomen and around the dorsal fin for a pit tag. If a PIT tag is scanned, record the PIT # on the back of the data sheet.

Adipose Presence – Yes, Partial, No, Unknown. A missing adipose fin indicates a hatchery fish. If 25-75% of the adipose fin is present, mark partial.

Snout ID tag – Scan the snout of the fish for a Coded Wire Tag (CWT). Make sure to lift the fish off the ground and clear the head of sand; the magnetism of the sand/ground can set off the wand. Be sure there is no metal on the hand holding the fish (ie. watch, cuff snaps). If there is a CWT, remove the snout by cutting across the head, straight down and directly behind the eyes, to the mouth. Place the snout in a plastic bag with a numbered snout coin, record the coin number on the data sheet.

Genetic ID# – With clean scissors, cut a small piece of tissue from the dorsal fin, approximately 5 mm^2 (slightly smaller than the size of the vial cap). Insert the sample into the vial that contains ethanol and record the vial number on the data sheet. Use a sharpie to mark the vial cap with an X. If the dorsal fin is too eroded or decomposed, take a sample from the fin in best condition.

Spawn Success – IN FEMALES ONLY. Cut open the abdomen to assess the number of eggs released. Complete (all eggs released), Incomplete (no eggs released, eggs still encased in the skein), Partial (some eggs have been released), Unknown (carcass too decomposed to tell).

Sex – Some external morphological characteristics may be obvious to determine sex, ie. large kype or hooked nose for males, eggs falling out of females. If secondary sexual characteristics are not obvious cut open the abdomen to examine the gonads. Females will have eggs or voided egg skeins with some small undeveloped ova. Males have white, milky, rubbery testes that may be enlarged or have receded through spawning.

The remaining columns on the data sheet will be filled out in the lab.

Scale Removal

Scales are used to identify freshwater and saltwater growth periods (age), to determine hatchery or wild origin, and rearing environment (ocean, reservoir, or river; Fraser & Hamstreet, 2016). Scale removal is an art; there are different techniques that work, so get in there and get your hands slimy! With a forceps, remove six scales from each side, two to three rows above the lateral line, between the posterior insertion of the dorsal fin and the anterior insertion of the anal fin (Figure 11). Scales are one sided, with the growth rings occurring only on the outside of the scale. Scales must be oriented correctly on the scale card to be read and stored properly. When pulled from the fish, the ridged side is generally up (but not always, depending on your scale removal technique). The ridged side needs to be face up on the gummy scale card. To check, use a pencil or forceps to feel the ridges, or lack thereof. The ridge side will also accept a pencil

mark. Salmon scales are slightly curved, and should be placed concave (cup) side down. Make sure the scales are clean before being placed on the scale card (Figure 12). Scales need to be oriented in the same direction to make reading easier. With the fish oriented with the head on the left, pull the scales out of the skin from the right and place the scale on the card without changing the orientation. Left handed surveyors can orient the fish in the other direction if preferred.

The scale card needs to be protected from rain and from rubbing against equipment in your pack. The card also needs to remain flat, as it will curl if damp. Curled scale cards are a pain to work with in the lab. In 2017, we started using thick Rite-in-the-Rain paper (item #1758511), cut slightly larger than the scale card. Rubber cement was used to adhere the scale card to the thicker paper and were then hole-punched to fit in the yellow field books.

After each carcass has been completely sampled, CUT THE TAIL OFF! This will indicate that the carcass has been sampled and in the future, if you see a carcass with no tail, you know it has already been sampled.

Post-Field Day

When back at the office, make sure the data headers are filled in with date, samplers, reach number, and species. Leave the cards out overnight to dry. In the morning, file the cards in the appropriate file folder in the office.

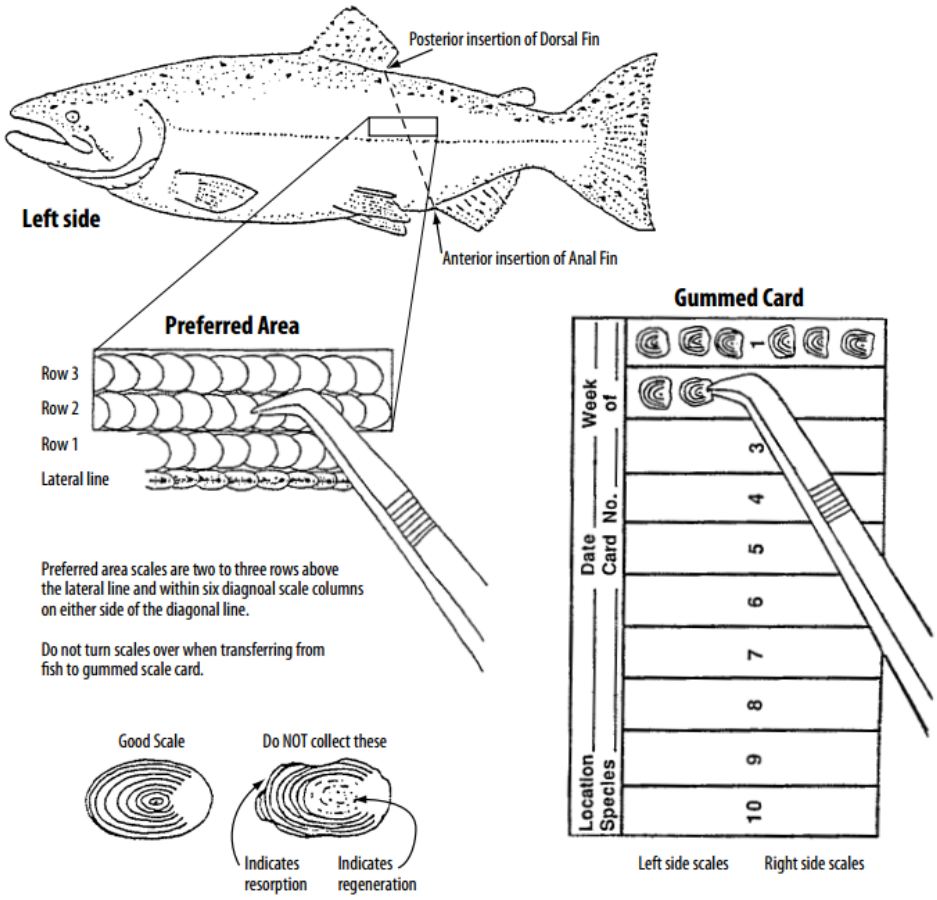

Figure 11. Image of preferred area for scale removal (Heindl 1989).

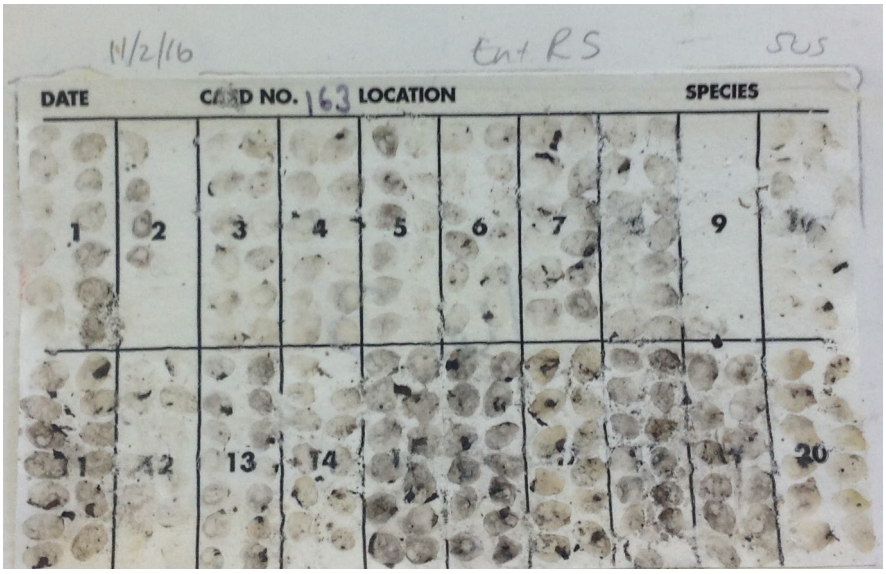

Figure 12. Example of an ideal scale card: clean, orderly scales on a card that remained flat.

Spawning Ground Survey Equipment List

Electronics Kit

- iPad, dry bag
- inReach
- Camera
- External battery
- iPad cord, inReach cord

Fish Kit

- Field notebook
- Pencils, sharpies
- Thermometer
- Scissors, tweezers
- Measuring tape
- Genetic ID vials
- Scale cards
- Knife
- T-wand
- PIT wand
- Head bags & disks
- Stringer
- First aid kit
- MSR water filter
- Flagging tape (backup)

Personal Kit

- Waders, boots
- Wading Poles
- Polarized sunglasses, sunhat
- Sunscreen
- Lunch and snacks
- Water
- Extra layers/ change of clothes

Bike Shuttle Kit

- Bike
- Helmet
- Lock

Kayak Kit

- Inflatable kayaks
- Paddles + spare
- Life jackets + whistle
- Throw bags
- Floor pump, hand pump
- NRS straps
- Dry bags for personal gear

inReach Use and Field Communication Protocols

This section describes the ins and outs of the inReach units: what it is, how to send/receive messages, potential pitfalls with solutions and the Hatchery Evaluation Team's (HE) communication protocols. In 2016, Garmin (producer of GPS units) purchased DeLorme and created new inReach units. As of September 2018, the USFWS inReach units in use are the older DeLorme units, as described in this document (Figure 13).

Figure 13. The Delorme inReach Unit used by USFWS.

inReach Basics

The inReach is a device that allows two way satellite texting for field communications. It can send and receive texts to/from phones, emails, and other inReach units. Location/GPS coordinates are attached to messages sent from the inReach. inReach units are equipped with an SOS button that acts like a 911 call, and should only be used like a 911 call. The USFWS inReaches are for professional use only. No personal texting is allowed.

There are *three pre-programed* messages, ten quick messages, and custom messages you can type yourself. You can send a text to as many people as you choose. However, the recipients of your text do not know who the text was also sent to. Lost your keys and sent a message? No one knows who you sent the text to or if anyone else has responded to you. If you sent out a group text and someone replies, only the inReach receives the message. So, in your text, make sure you

note who the text was sent to. If you are replying to an inReach message, communicate with the recipients of the inReach text to tell them you responded. It is important to designate an office contact to respond to the inReach message and communicate with the other recipients of the message.

Pre-programmed messages have the text and the recipients pre-programed and can be sent with a click of a button. As of September 2018, HE's messages are (recipient in parenthesis, sent to both emails and cell phones for each person):

Off the river, all is well! (MC, GF, HP, CH)
Running late, lots of redds! (MC, GF, HP, CH)
Lots of carcasses, please send assistance if possible. (MC, GF, HP, CH)

Quick texts are already typed, but you need to hand select the recipients on the unit. You can add additional text to the quick texts before sending the message. As of September 2018, HE's quick text messages are:

I can't reply, I'll write later.
I'm checking in, everything is okay.
I'm starting from here.
I'm stopping here.
I'm having a great time!
I'm on my way.
I am going to be late.
Yes
No

For *custom texts*, you can use the inReach unit to tediously type out a message. If one person is frequently using a specific inReach unit, that person's cell phone can be matched to the unit via bluetooth and the Earthmate App. This way the user is texting with their phone and sending the

message through the unit. Installing and using the Earthmate App is not covered in this document.

How to Send a Message

This section describes how to use the inReach device for first time users.

Figure 14. TheDelorme inReach unit working interface.

Power On

- Press and hold enter (check-mark; Figure 14)
- "Power On" and "Cancel" tabs will appear
- Press the arrows to select "Power On" (green highlights the tab selected)
- Press enter

Unlock

- Press enter
- Press the arrows to select "Unlock"
- Press enter

Power Off

- Press and hold enter
- "Power Off", "Lock Screen" and "Mute Sounds" tabs will appear
- Press the arrows to select "Power Off" (green highlights the tab selected)
- Press enter

Send a Preset Message

- Press and hold the X key
- Select the message you want to send and press Enter
- inReach will send Preset text to preset individuals

Send a Message (Quick Text or Custom Text)

- Select "Messages" on home screen and press Enter.
- Select the "To" field and begin typing contact address or phone inReach will autofill recipients (managed online)
- Select Message field and compose your message OR use Select to pick from Quick Text. Quick Text uses commonly used phrases instead of typing out text.

Was your message sent? The bullseye/crosshair next to message indicates it was sent (Figure 15, red circle). The indicator light will blink green if the unit is receiving a satellite signal; blinking red means no satellite signal (Figure 15, orange square). Play around with the unit to familiarize yourself with it.

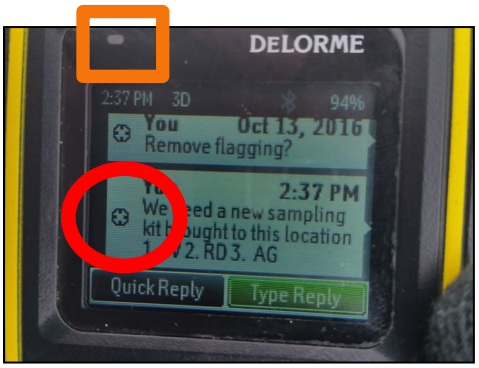

Figure 15. The bullseye/crosshair to the left of the message (red circle) will tell you if your message was sent. The indicator light is shown with the orange square.

inReach to inReach Texting

inReach to inReach texting is a convenient way to communicate with other field crews**.** There is a specific email contact address assigned to each unit, which can be found on the online profile for each individual unit (Appendix B, Figure 27). As of September 2018, HE's contact address for each unit is:

Unit 1 - HE_Unit1@inreach.garmin.com
Unit 2 - HE_Unit2@inreach.garmin.com
Unit 3 - HE_Unit3@inreach.garmin.com

These contact addresses change, depending on what email is attached to the unit (ie. if the unit is assigned to a person with a personal email, the unit contact address will change). To contact other inReaches, such as the Native Fish units, have a Native Fish employee confirm the contact address with the online profile for the unit before leaving for the field. Texting to a unit is the same process as texting to a phone. Depending on satellite coverage for both the sending unit and the receiving unit, there may be a time delay in sending/receiving messages. If the receiving unit is not turned on, it will not receive a message until the unit is turned on and locates satellites.

HE Field Communication Protocols

Hatchery Evaluation and Native Fish Programs have different protocols that may eventually merge. But for now (September 2018), the following protocols are HE's for field communication and using the inReach.

Before leaving for the field, designate one office contact for the day (Table 4). Communicate with this person so they know they are the responsible party. Fill out the trip plan on the white board in Building #2. Make sure to include samplers, reach #, mode of transport foot/kayak/cataraft, vehicle, inReach unit (HE Unit 1, HE Unit 2, or HE Unit 3), and the office contact person. Double check the inReach is fully charged. If the unit was left on overnight in the office, it will most likely be dead due to searching for satellites all night long.

While on the river, if there are two crews, keep the unit on for field communication. If there are forest fires in the area, keep the unit on in case the crew needs to be reached. Otherwise, keep the unit off to conserve battery. The SOS function can be used when the device is turned off.

Since the HE field crew goes to the same river every day and the reaches are well defined, we only send out one message at the end of the survey "Off the River, All is Well." Most surveys will be completed by 3:00 pm. During peak spawning, field days may be longer. If you are still on the river at 3:15 pm, send the message "Running Late". This way the office contact will receive the message before the end of the work day at 3:30 pm. If you are still on the river at 5:00pm, send another "Running Late" message. At 5:30 pm, no matter where you are on the river, leave the river. Send the message "Off the River" and walk to the bike or car to complete the shuttle. When in cell service, call or text the office contact to let them know you are on your way back. The reason for the 5:30pm departure from the river is so there is enough time and sunlight to initiate a rescue if needed.

If you are the office contact and you have not heard from the crew by 7:00 pm, text the field crew members on their personal cell phones. Don't worry yet. The crew may have forgotten to send messages (shame on them!) or the satellites didn't allow the inReach messages to go out. By 7:00 pm, the crew should be either on their way home or at the bar and should be able to text you back almost immediately. If by 8:00 pm you haven't heard anything from the crew, now is when you can start worrying.

STEP ONE: Call USFWS employees based in Entiat (Entiat NFH has staff living on station). Know which reach the crew is on and exactly where the car and bike should be (Table 1). Ask if the Entiat based employee can drive up the Entiat River Road to investigate. Is the field crew's vehicle still at the start of the reach? Is the bike at the end of the reach?

STEP TWO: Call the field crew's personal cell phones again.

STEP THREE: Call Project Leader or Supervisor to inform them of the situation.

STEP FOUR: Wait for a report from the Entiat based employee. Were the car and bike still in place? Crew is still on the river somewhere. Call RiverCom to start a rescue mission on the river. Was the car gone? Drive further down the road to see if there was an accident. Call RiverCom to let them know what's up. Once the crew is located, make sure to call all parties involved to update the whereabouts and to end worrying.

Table 4. Field communication protocol for HE field crews.

Time	**Field Crew**	**Office Contact**
Pre- departure	Fill out trip plan Designate an office contact for the day	Confirm field members and survey reach
Post- sampling	Send message: "Off the River, all is well!"	
If on the river at…		
3:15 pm	Send message: "Running Late"	
5:00 pm	Send message: "Running Late"	
5:30 pm	LEAVE RIVER, send message "Off the River" When in cell service, call/text office contact	
7:00 pm		IF NO CONTACT FROM FIELD, call/text field crew members' cell phones
8:00 pm		IF NO CONTACT FROM FIELD, initiate local response (Entiat office and hatchery employees)

Setting up the inReach – Preseason

Before starting the field season, the inReaches need to be activated, contacts need to be updated and pre-set messages need to be created. All of this is managed online:

www.inreach.garmin.com

Each unit can be updated from the individual unit account, or the can be updated from the administrator's master account. HE has three units with the following log-in information:

Usernames:

HE_Unit1@yahoo.com	password:
HE_Unit2@yahoo.com	password:
HE_Unit3@yahoo.com	password:

The main features managed online are: emergency contacts, contact email and phone numbers, and pre-set and quick messages. There are other functions online that you can explore on your own and are not covered in this document. Once you are done updating your online account, you need to sync your device. Plug your unit into the computer and click the red "SYNC" tab. Changes will not be reflected on the unit until it is synced. Contacts can be typed in manually to the device if needed. Appendix B shows what the online interface looks like for managing the inReach units.

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APPENDIX A – GISPro App

Appendix A contains step by step guides for setting up the GISPro app for spawning ground surveys prior to the field season. Downloading basemaps requires wireless internet connection. Setting up a new project and creating points and data templates do not require internet connection.

Set up a New Project (preseason)

Tap the GIS icon to open the app. If a project opens, return to the start screen by tapping the upper-left corner "home" button and/or the double square icon (Figure 16, green circle).

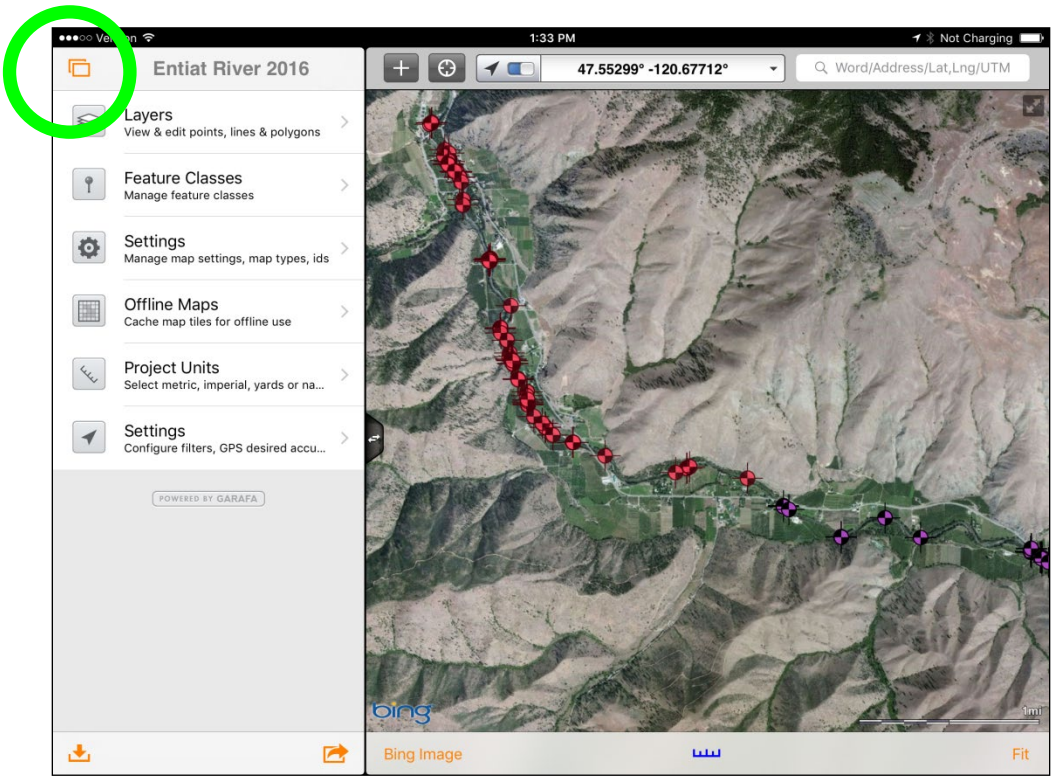

Figure 16. To return to the start screen, tap the double rectangle in the upper left-hand corner.

To create a new project, select the “plus” button at the bottom center of the start screen (Figure 17, green circle).

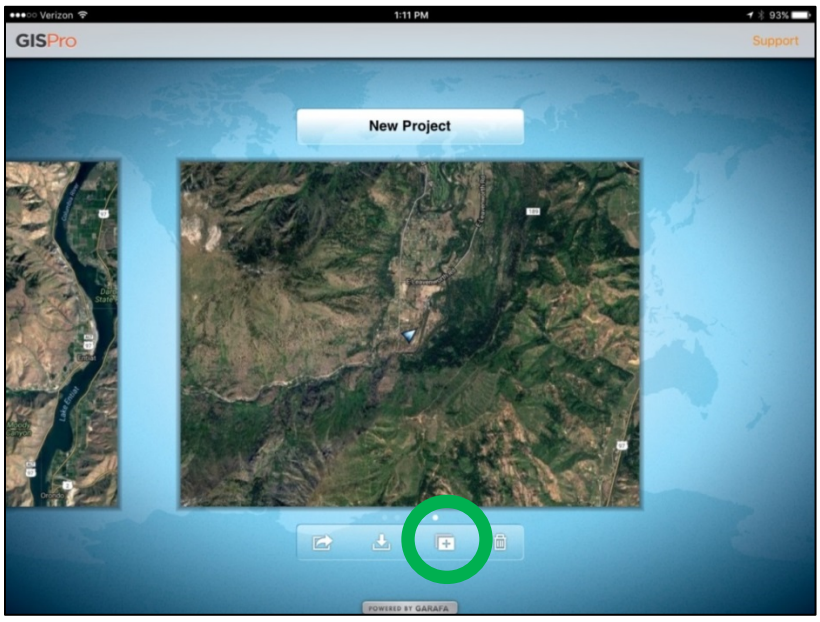

Figure 17. To start a new project, select the “plus folder” (green circle) on the start screen.

You can rename your project by tapping the title. In this case, tap “New Project” (Figure 18, green rectangle) and a keyboard will pop up and you can type in your new project name.

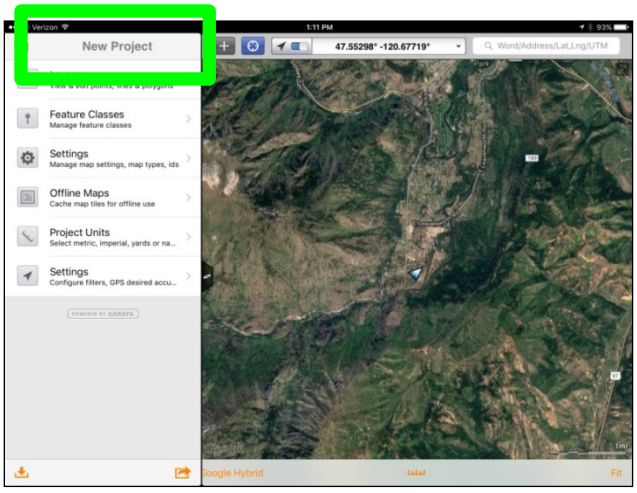

Figure 18. To rename your project, tap the title “New Project” and a keyboard will pop up to type in the new project name.

Download Basemaps (wireless internet connection needed)

Downloading basemaps is the only portion of the set-up that requires wireless internet connection. When connected to wireless internet, from the home screen tap “Offline Maps” (Figure 19, green rectangle).

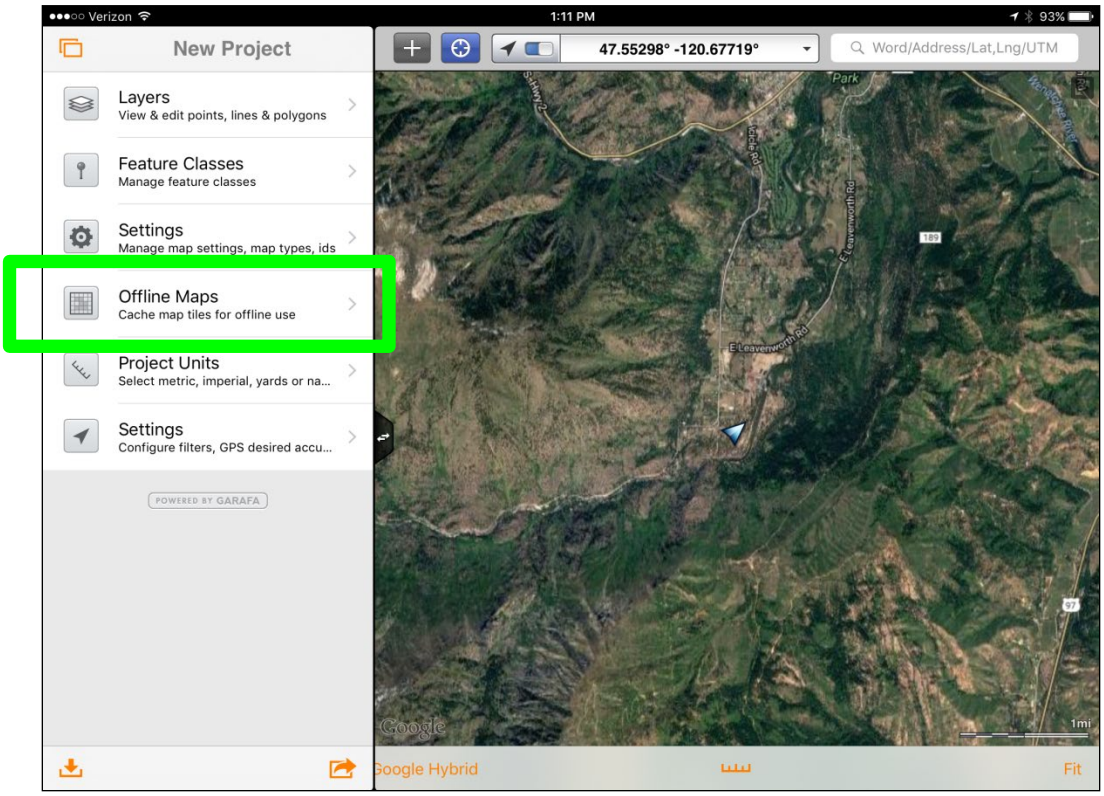

Figure 19. To download maps into a new project, select “Offline Maps.” Wireless internet connection is required.

Select “Add New Cache Region” from the Offline Maps screen (Figure 20A). Select “Bing Image” for the highest satellite image resolution from the Map Type screen (Figure 20B). Select “Free Draw Area” to outline the river (Figure 20C). Select “Very High” from the Resolution screen (Figure 21). Tap “Tap to Draw” and outline the portion of the river you are working on. A polygon feature will be closed with a straight line unless you finish drawing the

shape. Select “Cache” to start the download. Remain in wireless internet connection until the download is complete.

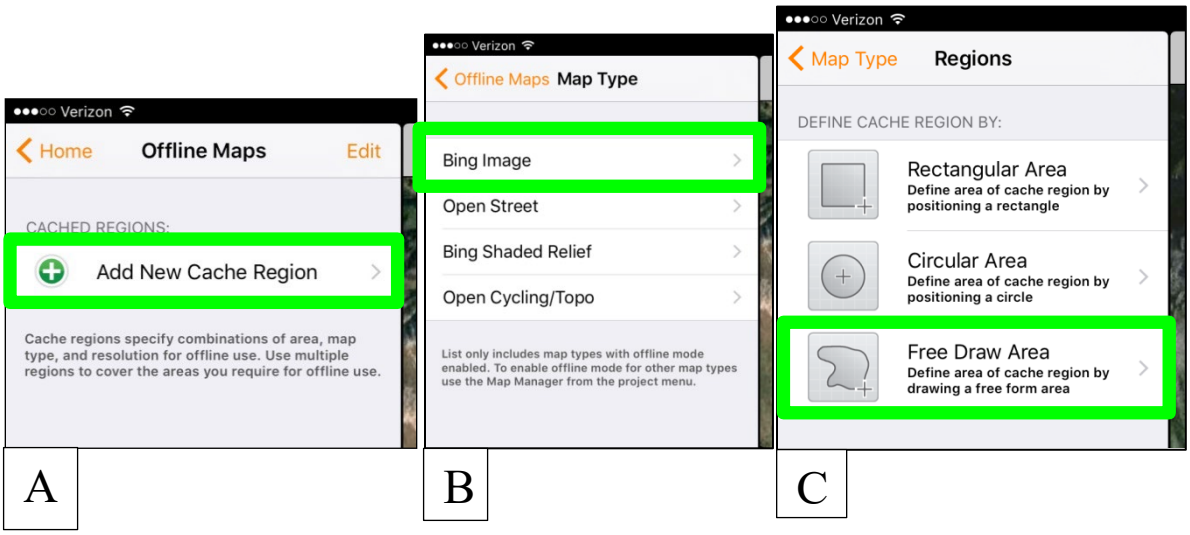

Figure 20. Select “Add New Cache Region” (A), “Bing Image” (B), and “Free Draw Area” (C) to download a basemap.

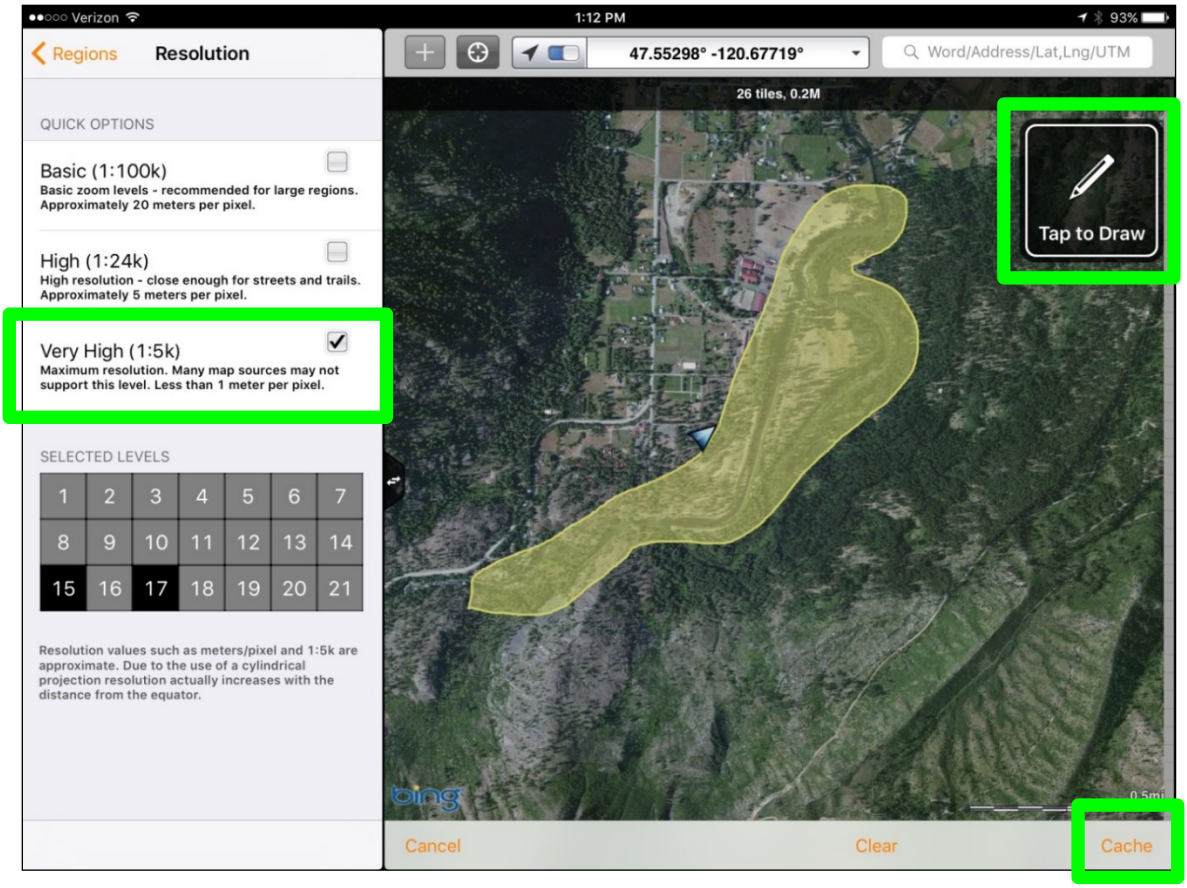

Figure 21. Select “Very High” and then “Tap to Draw”. Trace the area on the map you would like to download. Tap “Cache” to start downloading the basemap. Wireless internet connection is required.

Create Points to Mark Redds and Carcasses (Preseason, no internet necessary)

As mentioned in the Redd Survey Protocol section, each redd and carcass is marked with a point that is specific to the reach and the run of salmon. The points used to mark each redd or carcass are created under the "Feature Classes" section. Each point under Feature Classes creates a data template for collecting the data in the field. Once a Feature Class is created, it can be exported to iTunes and imported back into the app to be renamed and used as a data template for another point.

To create new points, select "Feature Classes" from the main screen (Figure 22).

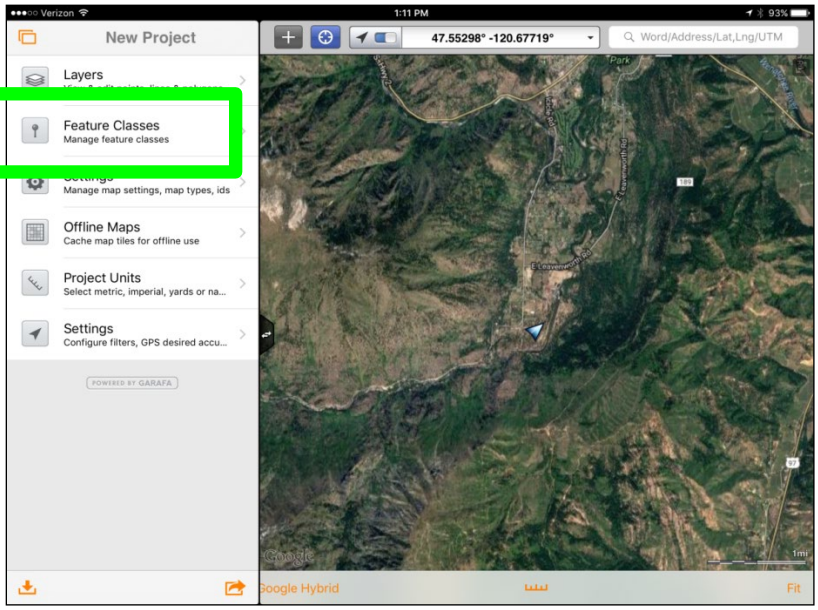

Figure 22. To make points to mark a redd or carcass, select "Feature Classes".

Select "New Feature Dataset" at the bottom of the column (Figure 23). A Feature Dataset is the folder that contains all the points you want to use for one project. In the past, one was created for redds and one for carcasses. All Feature Datasets are accessible for all projects on the iPad. You can turn on/off Feature Datasets by sliding the button on the folder icons for each project. *General note: Once something has been deleted from the app, there is NO undo button!* The info you delete will be gone forever, so please don't delete any feature classes that came with the app.

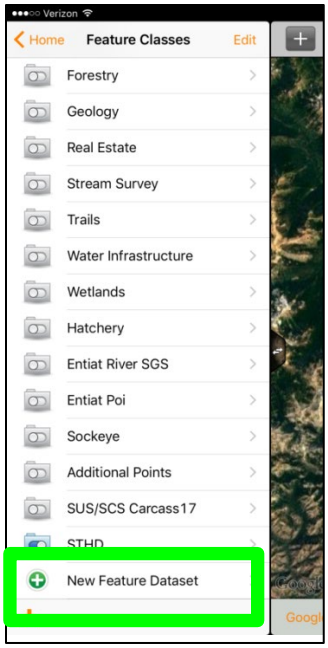

Figure 23. Select "New Feature Dataset" to create points to mark a redd or carcass.

Next, rename the new dataset folder (Figure 24, blue rectangle). Chose a name that is specific to the project, such as "Spawning Ground Surveys 2018." Select "New Point Class" to create a new point (Figure 24, green rectangle). Create one point class for each reach (Entiat 1-5) and for each run (SCS and SUS; Figure 25) for both redds and carcasses. For the redds, rename the New Point to reflect the USFWS naming scheme for the redd by run, year, reach, and redd #:

SUS16R4R SUS= Summer Chinook, 16=year, R4= Reach#, R = Redd#

For the caracass points, name by run, "Carcass", and R#:

SUS CarcassR2

The app will automatically use the point name and give it the next sequential number. So, name the point class without the redd or carcass number, which will be added when you place a point on the map. For each point created, you can edit the point style and color by tapping the icon on the new point screen (Figure 26, green square), as this will help distinguish between reaches and run.

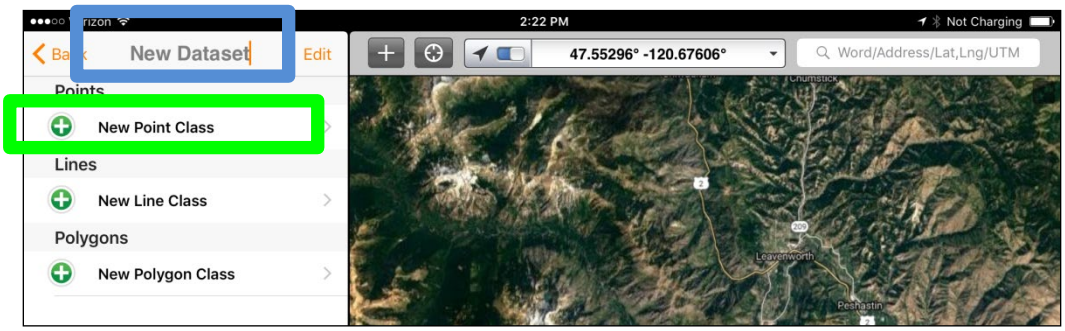

Figure 24. Rename the Feature Class by tapping the name "New Dataset" and create a new point by tapping "New Point Class."

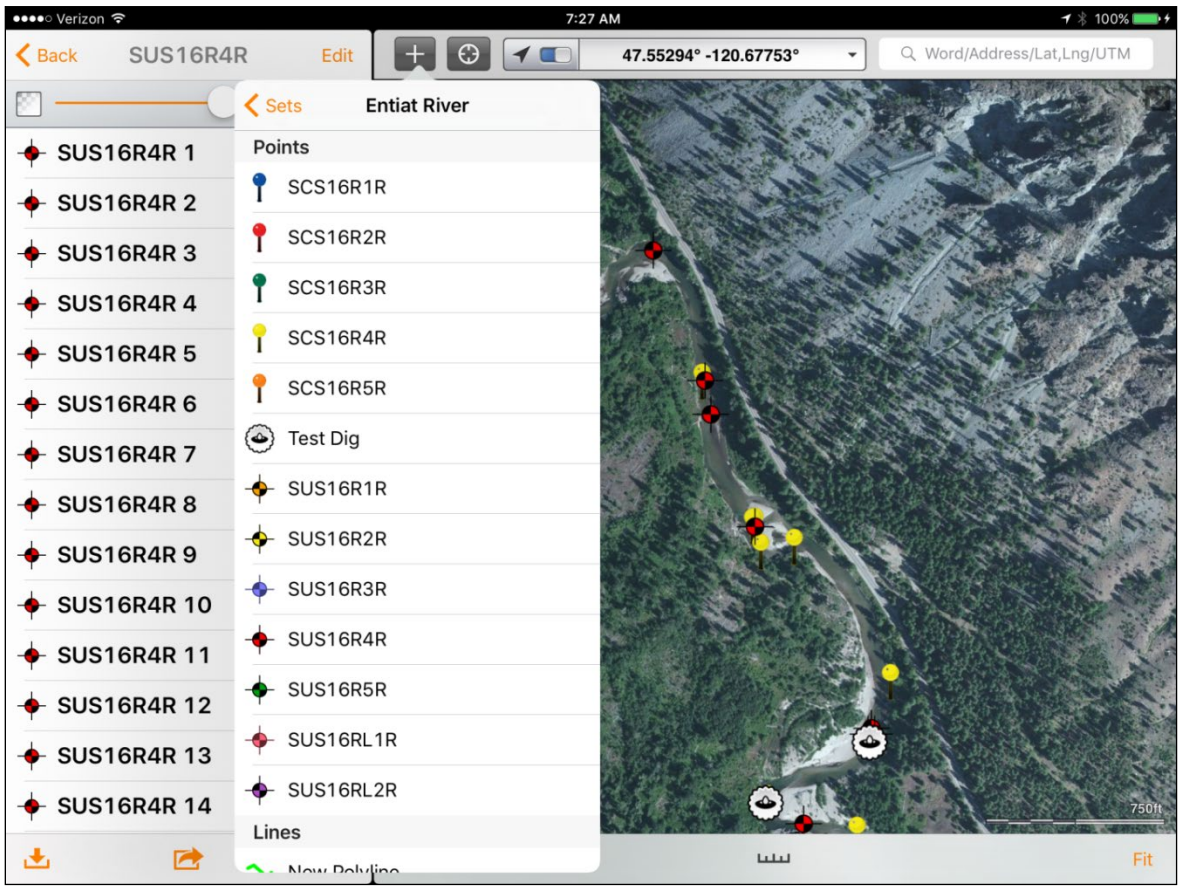

Figure 25. Entiat River points created for spring Chinook Salmon (SCS) and summer Chinook Salmon (SUS) for each reach (R1-R5, RL1, RL2; white column). The app automatically numbers the redds in sequential order for each reach (left column).

Data Templates for SGS Data Collection (Preseason)

Each point created will have a list of "Attributes" associated with the point, which is where you can create your data collection template. A data template needs to be developed for each point. From the point screen, tap the "i" icon on "Add Attribute" (Figure 26, blue rectangle). There are a number of attributes to choose from and you can create required attributes by sliding the "Required" toggle (Figure 27, green arrow). If an attribute is required, you must enter that data to move on from the point. Once you have created your list of attributes, you can reorder them by tapping "Reorder" (Figure 26, orange circle). After tapping reorder, tap and drag from the three lines to the right of each attribute (Figure 28, red square) to your preferred order. Tap "Reorder" to save your work. When naming the attribute (Figure 27, blue rectangle), do not use spaces or special characters. Instead, use an "underscore" (_) to separate words. This will help when exporting data into a program for analysis.

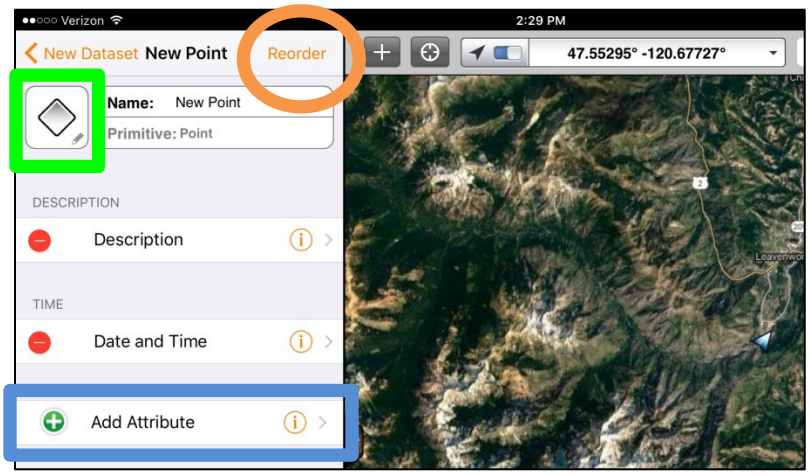

Figure 26. The "Add Attribute" function builds the data template (blue rectangle). To reorder attributes, tap "Reorder" (orange circle) and tap and drag the three lines on the right hand side of the attribute (Figure 28, red square). Tap "Reorder" when done. Tap the point icon (green square) to edit the point style for each specific point.

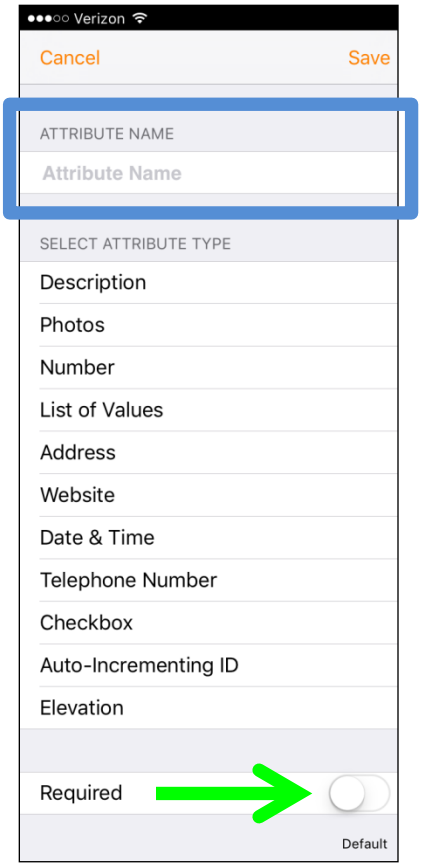

Figure 27. This figure shows the attributes you can add to the data template. The "Required" toggle can be activated (green arrow), which means data must be entered into the required attributes before moving on to a different page within the app. When naming the attribute (blue rectangle), do not use spaces or special characters.

The 2018 redd data templates contained the following attributes (Figure 28):

Description

Length_M

Width_M

Photos

Time (Automatic – set in settings)

Superimposition (Required) [only for the summer Chinook data templates]

The 2018 carcass data templates contained the following attributes (Figure 28):

Lgth_Fork

POH

Adipose_Presence (List of Values: yes, no, partial, unknown)

Genetic_ID

Sex (List of Values: male, female, unknown)

Spawn_Success (List of Values: complete, incomplete, partial, unknown)

Scale_Card_Num

Scale_Position

Snout_Tag_ID

PIT_Tag_Num

Otolith_wild_SCS_only

Time

Notes

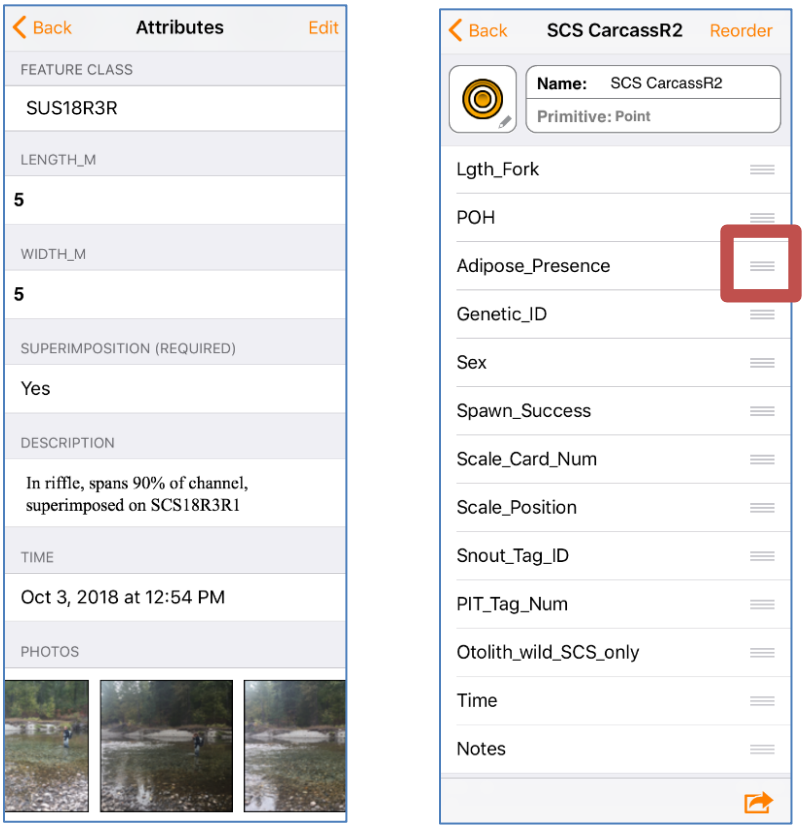

Figure 28. The left column shows the data template for the 2018 redd surveys. The right column shows the data template for the 2018 carcass surveys. To reorder the attributes, tap reorder, tap and drag the three lines to the right of the attribute (red square) up or down. Tap reorder to save work.

APPENDIX B - inReach

The images in this appendix show the online interface of the inReach. Each unit has its own account on www.inreach.garmin.com. Each unit can be updated from the individual unit account, or the can be updated from the administrator's master account. HE has three units with the following log-in information:

Usernames:

HE_Unit1@yahoo.com password:

HE_Unit2@yahoo.com password:

HE_Unit3@yahoo.com password:

Emergency contacts can be updated under the Account tab (Figure 29). The Account tab also shows the contact address for the unit to text inReach to inReach. HE's unit contact address are:

Unit 1 - HE_Unit1@inreach.garmin.com

Unit 2 - HE_Unit2@inreach.garmin.com

Unit 3 - HE_Unit3@inreach.garmin.com

Preset Messages and Quick Text Messages are managed under the Messages tab (Figure 30). Reminder: once changes have been made online, the unit must be synced (red Sync tab) for the changes to be reflected in the unit. Contacts are managed under the Contacts tab (Figure 31). Note that hand entered contacts into the unit will not be reflected online, but will not be deleted when the unit is synced.

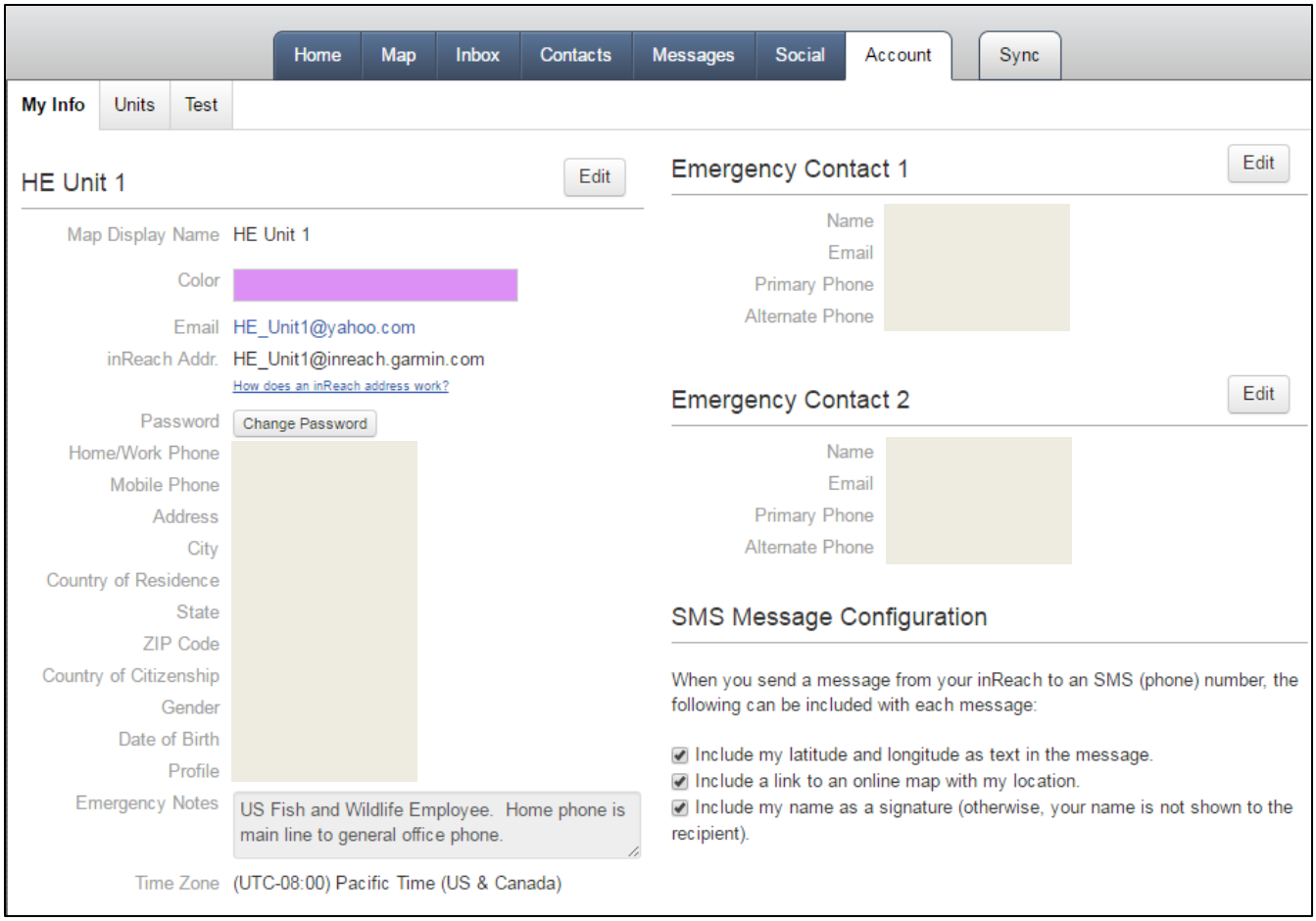

Figure 29. Under the account tab, updates can be made to the unit contact information and the Emergency Contacts. The “inReach Addr” is the contact to use for a different inReach to send this unit an inReach to inReach message.

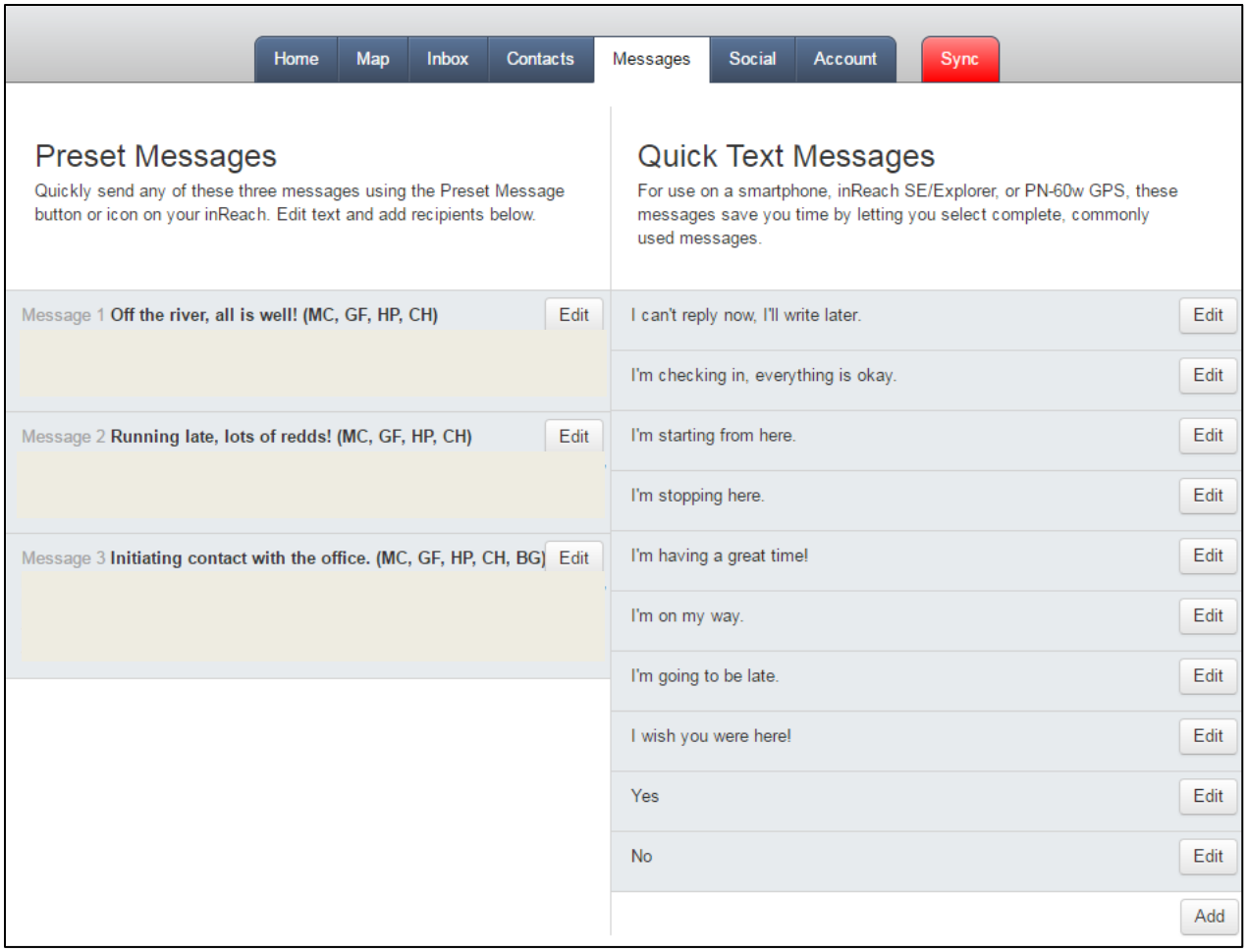

Figure 30. Manage the Preset Messages and the Quick Text Messages under the Messages tab. Once changes have been made online, the unit must be synced (red Sync tab) for the changes to be reflected in the unit.

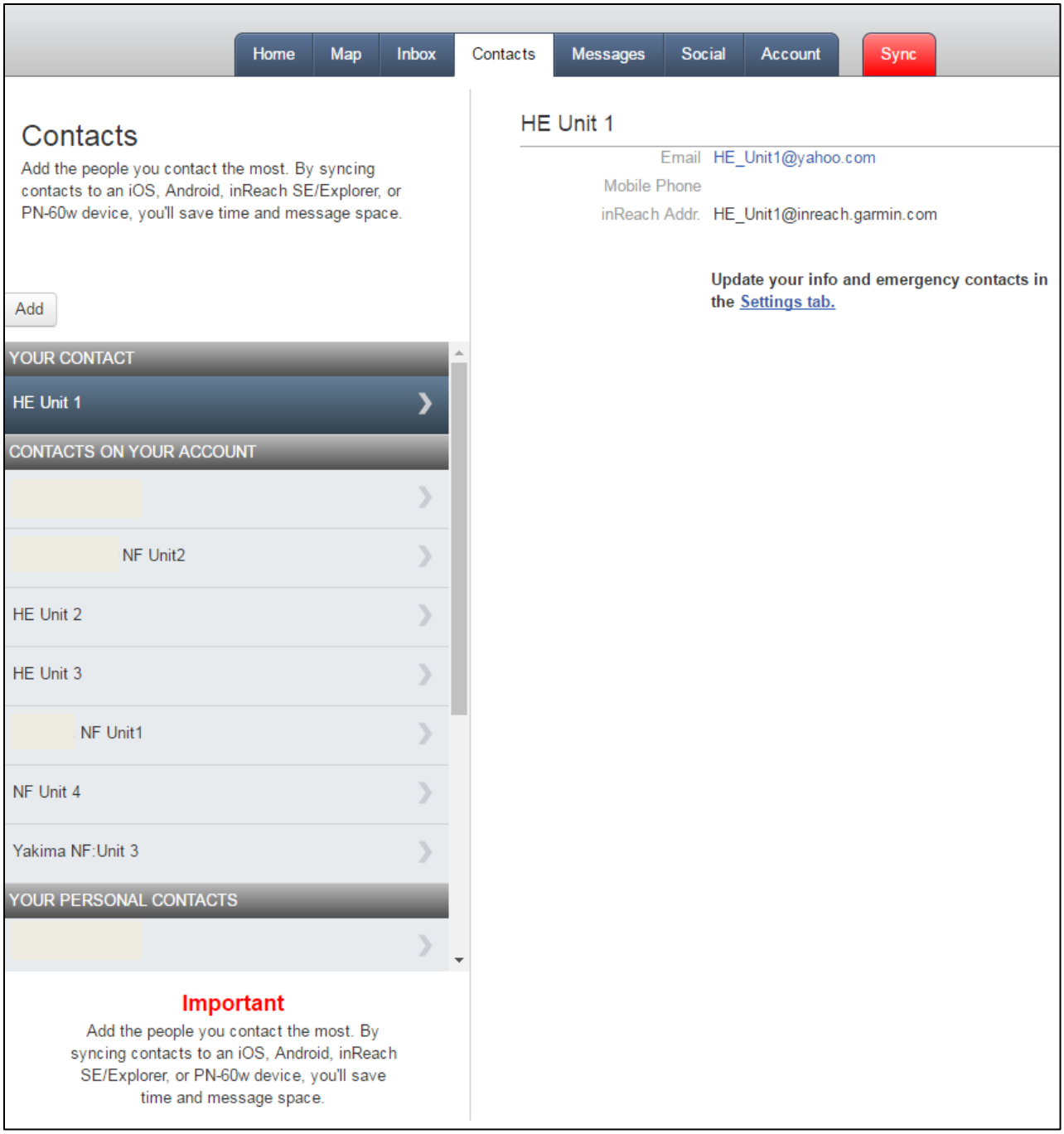

Figure 31. Manage contacts under the Contacts tab. It is much easier to add contacts online than it is to enter contacts into the unit. Note that hand entered contacts into the unit will not be reflected online.