Session II- Part A

A number of factors must be considered during the planning and execution of a sonar survey. We must address the question- will sonar mapping be effective on the study system? How should the survey be designed and executed? What range settings to use… and so on. In this chapter we address several factors relevant to sonar mission planning: navigation, the importance of depth and flow, selecting range settings, potential sources of water column interference, and issues related to weather and traffic on the water. Taking these considerations into account, in addition to gaining an informed perspective on the physical characteristics and behavior of your target study system, should improve your success on the water when sonar imaging.

Mission Planning

Pre-survey Considerations

- **Navigation**
- **Depth / Flow**
- **Range and Resolution**
- **Water Column Interference**
- **Weather and Traffic**

Navigation

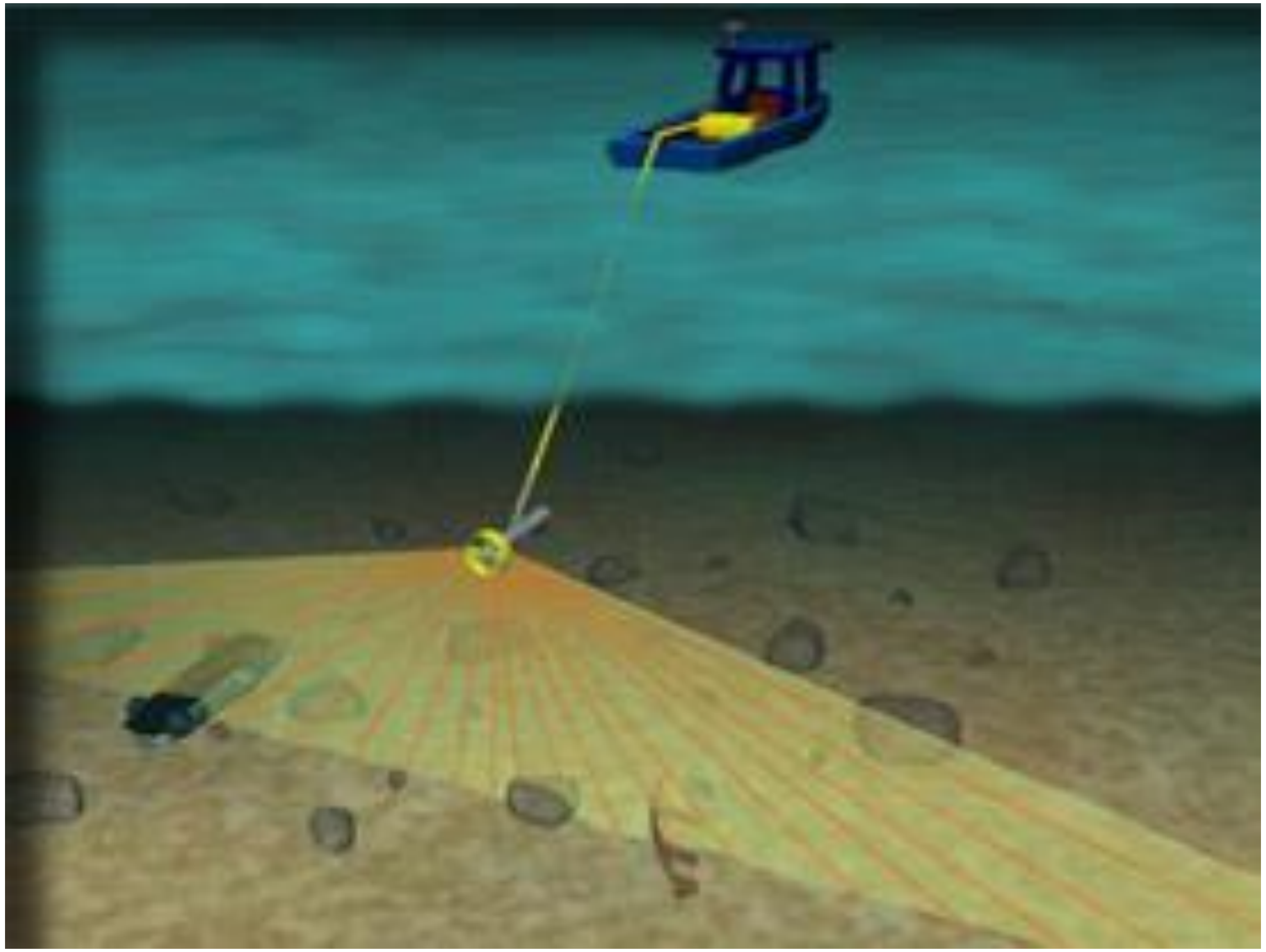
Study system morphology influences boat navigation, and consequently the quality of sonar imagery.

Side scan sonar was developed for optimal performance over flat terrain using straight-line survey transects. In other words, rivers and lakeshores with their twists and turns and sloped banks present a new, understudied, and sometimes challenging imaging environment for side scan sonar.

One should anticipate the potential for sub-optimal imaging performance when pushing the limits of SSS in certain applications (e.g., imaging a tight bend in a small, meandering creek).

Navigation

Truism #3- Side scan sonar performs best when used to image flat areas via straight-line transects



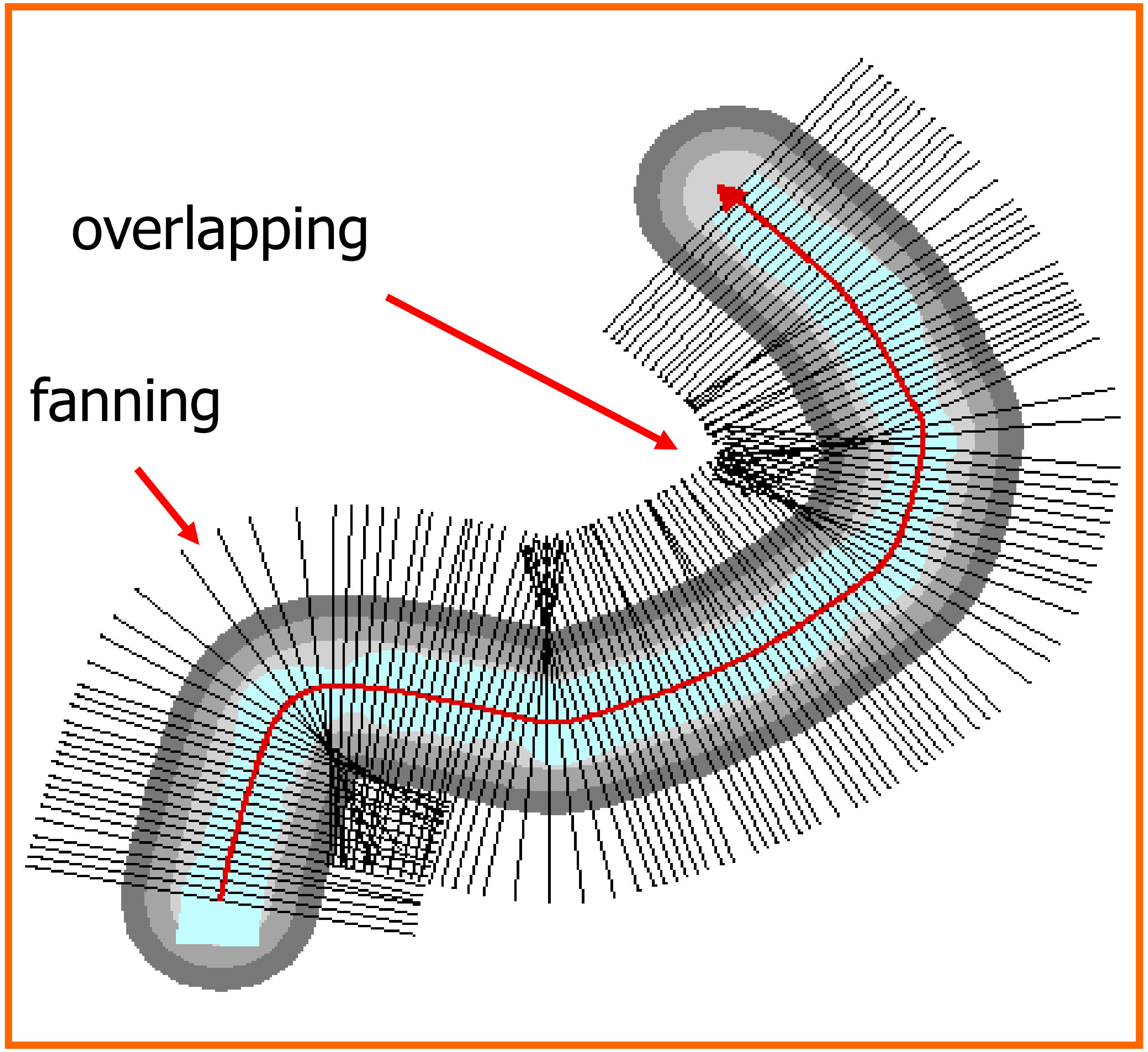
http://www.aquaticsciences.com/marine/Marine_Geophysical.htm

Boat Navigation

During navigation of sinuous transects, the sonar signal may overlap on the inside of a turn, and fan out along the outside of a turn potentially causing distortion and data gaps in sonar imagery. The degree of overlap or fanning (and hence distortion) will depend on several factors, including the radius of the turn, the range setting used, the pulse rate, and boat speed.

The best performance of SSS will be achieved during straight line navigation and gradual turning when necessary.

Navigation Issues



Effect of sharp turns

To illustrate the effect of navigation-induced image distortion, we captured imagery during navigation of two available routes around a small island in a reach of Chickasawhatchee Creek in Southwest Georgia. Heavy shoals (rocky areas) were located on the inside route. Both routes required evasive maneuvering to avoid disaster.

Chickasawhatchee Creek

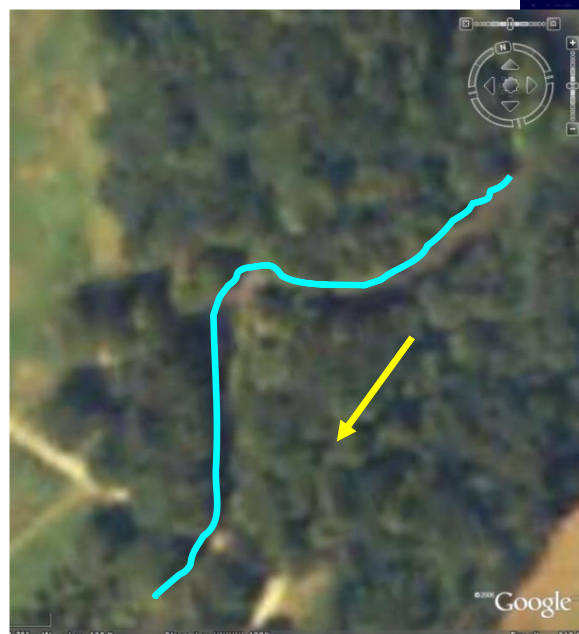
Narrow & sinuous channels could pose the following problems:

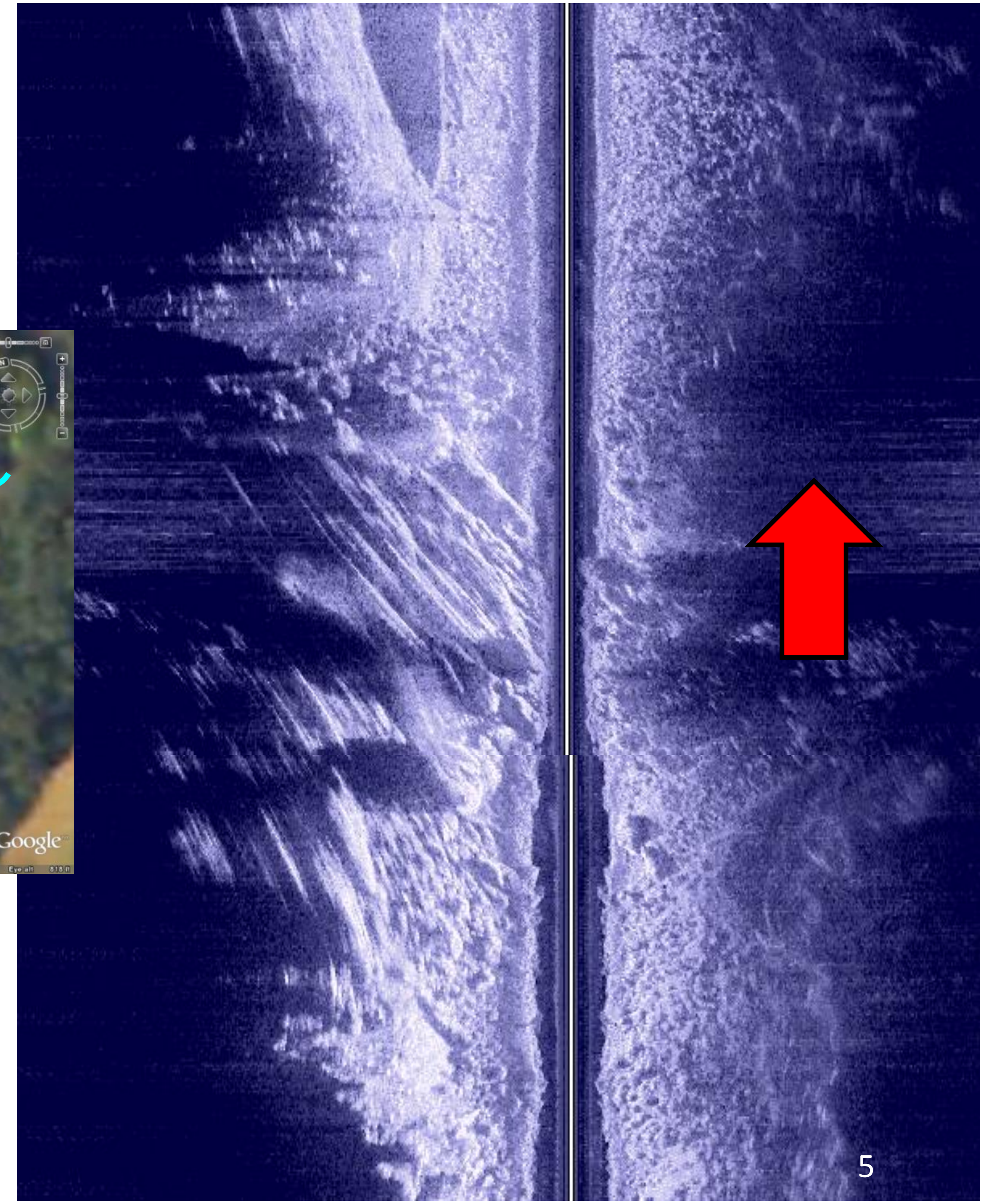
- Image distortion in bends due to pulse overlap
- Poor GPS accuracy under thick canopy

The Inside Bend

Navigating the inside route demanded a sharp turn to the left (port) as we approached the island (located approximately at the head of the red arrow on the raw sonar mosaic). Note the "stretch" distortion that occurred as a result of sonar beams overlapping back over previously insonified (i.e., scanned) areas. Just below the heavy shoal, the image appears somewhat hazy or milky in appearance- this is the effect of water column turbulence created by the rocky shoal. Note, too, that the island effectively blocks the sonar signal from reaching habitat on the far side of the channel.

Navigating Sharp Bends





The Outside Bend

Navigating the outside route also demanded a sharp turn to the left, distorting the image along this side. Here the island is more clearly defined as a signal blocking object protruding above the water.

Navigating Sharp Bends

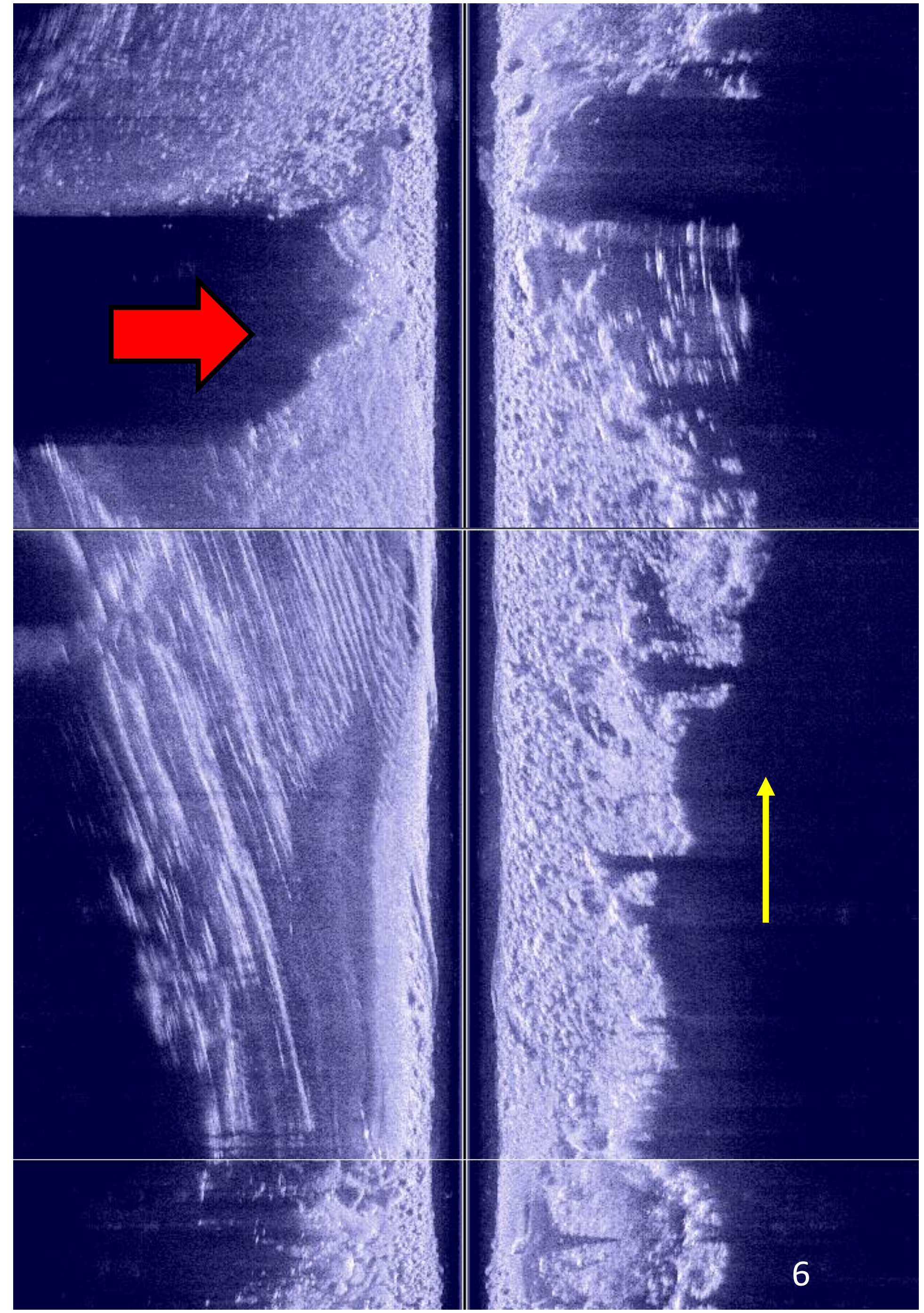
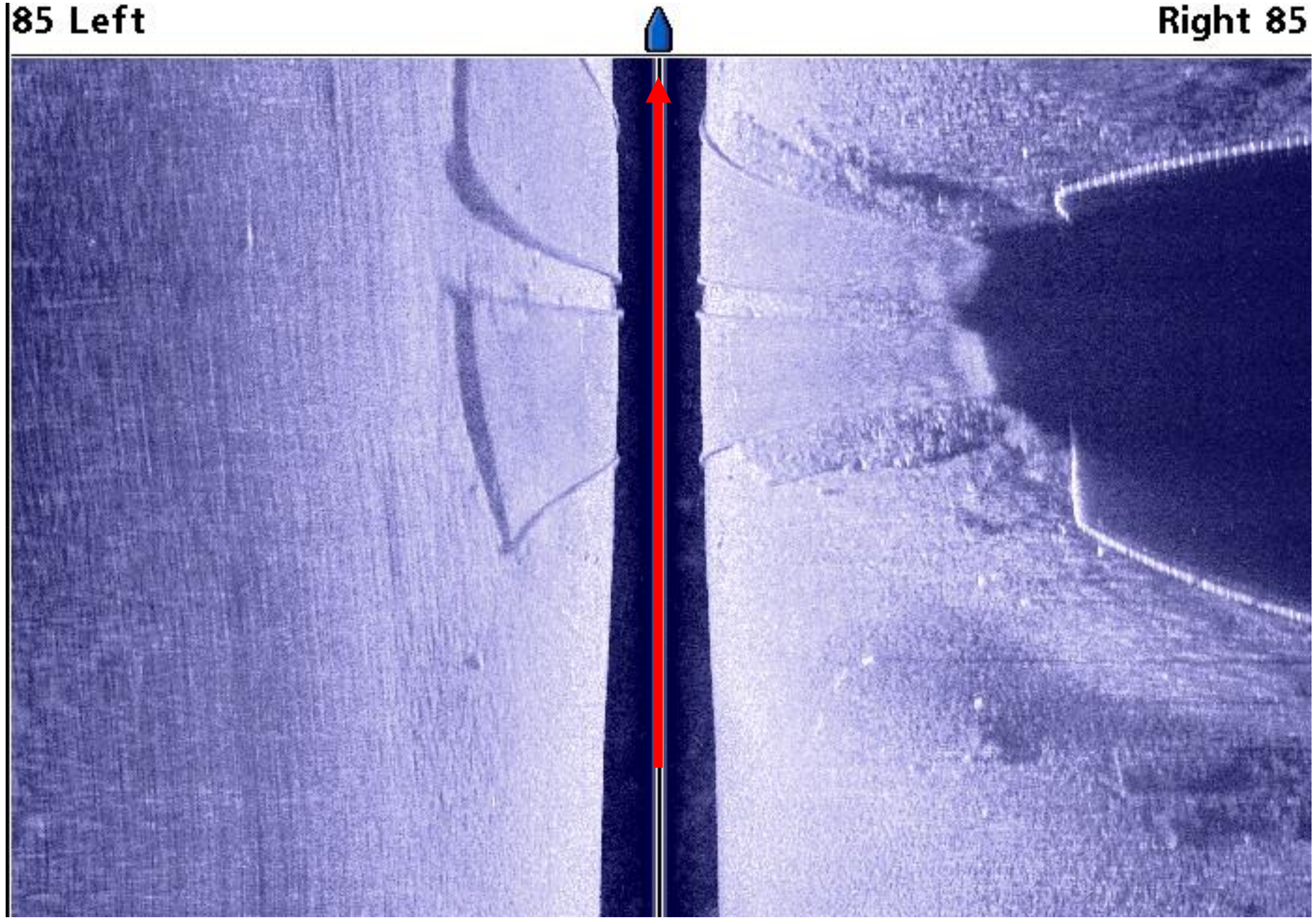


Image distortion

This example comes from a weekly monitoring study of fish bed production among coves in a reservoir. In this cove, we launched the boat from a concrete, two lane ramp, and began capturing imagery as we piloted the boat along the cove shoreline. This path, shown below, required a sharp left hand turn in front of the ramp. As the boat turned to the left, the signal pulses overlapped each other causing the ramp to appear stretched. In reality, the concrete slab was the same dimensions from toe to heel, thus we are looking at distortion caused by navigation.

Another Example

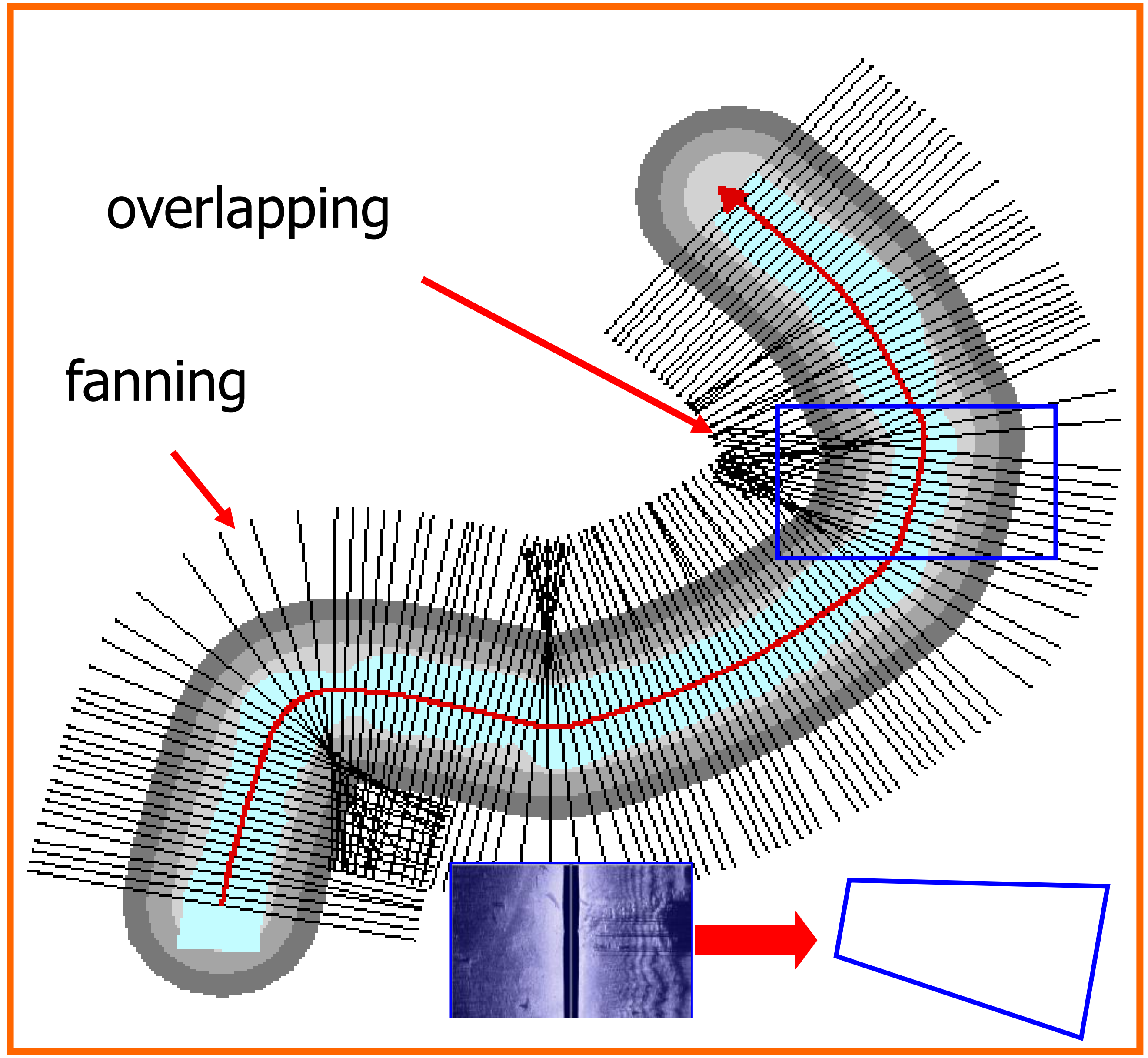


Can distortion be fixed?

Image processing (i.e., rectification) does help to correct navigation-induced distortion, but sometimes image "warping" occurs. Warping is the result of the computer failing to successfully transform or fit a raw, rectangular image into a non-rectangular, geometric space representing the actual area from which the image data was captured.

Will we discuss image warping, and means to prevent and to correct warping using methods Thom developed in Session III.

Navigation & Image Warping



SSS does not penetrate

The high frequency signals used by side scan sonar reflect off surfaces, rather than penetrate. Thus, it is not possible to image areas that are behind solid objects, or objects that protrude through the water column, like islands, bridge abutments, and shallow sand bars.

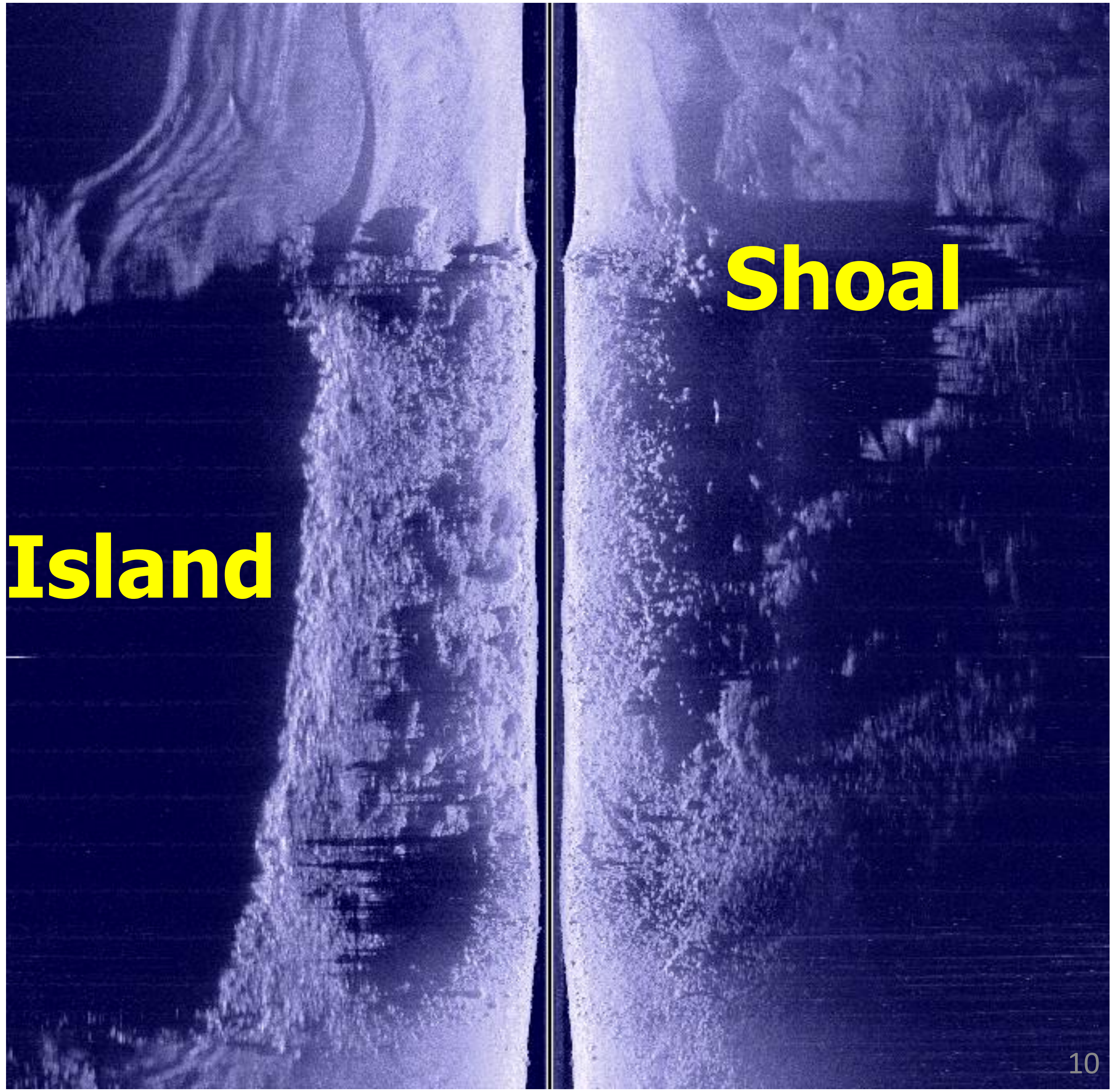
In the adjacent image there are several islands that effectively prevent the imaging of the entire river channel with a single boat pass. During this survey, we chose to navigate the main channel of the river and did not conduct a second pass down the secondary channel.

Signal Obstructions

SSS does not penetrate

The island appears on the left side of this raw image mosaic. The outer edge of the island is clearly defined, however, the secondary channel behind this island is not imaged, and represents missing data. Note too that a large boulder shoal occupied the main river channel adjacent to this island. Higher flows on the day of the survey allowed us to navigate over this shoal, even though the river was shallow in places along the boat path. Very shallow portions of the shoal that contained large protruding boulders cast areas of "sonar shadow". Areas obscured by sonar shadow also represent missing data. If the river discharge and stage were higher during the survey, the extent of the sonar shadowed areas would likely have been reduced. The opposite is also true, of course. If river stage was lower, more areas in this image may have been covered by sonar shadows.

Signal Obstructions



Using multiple passes

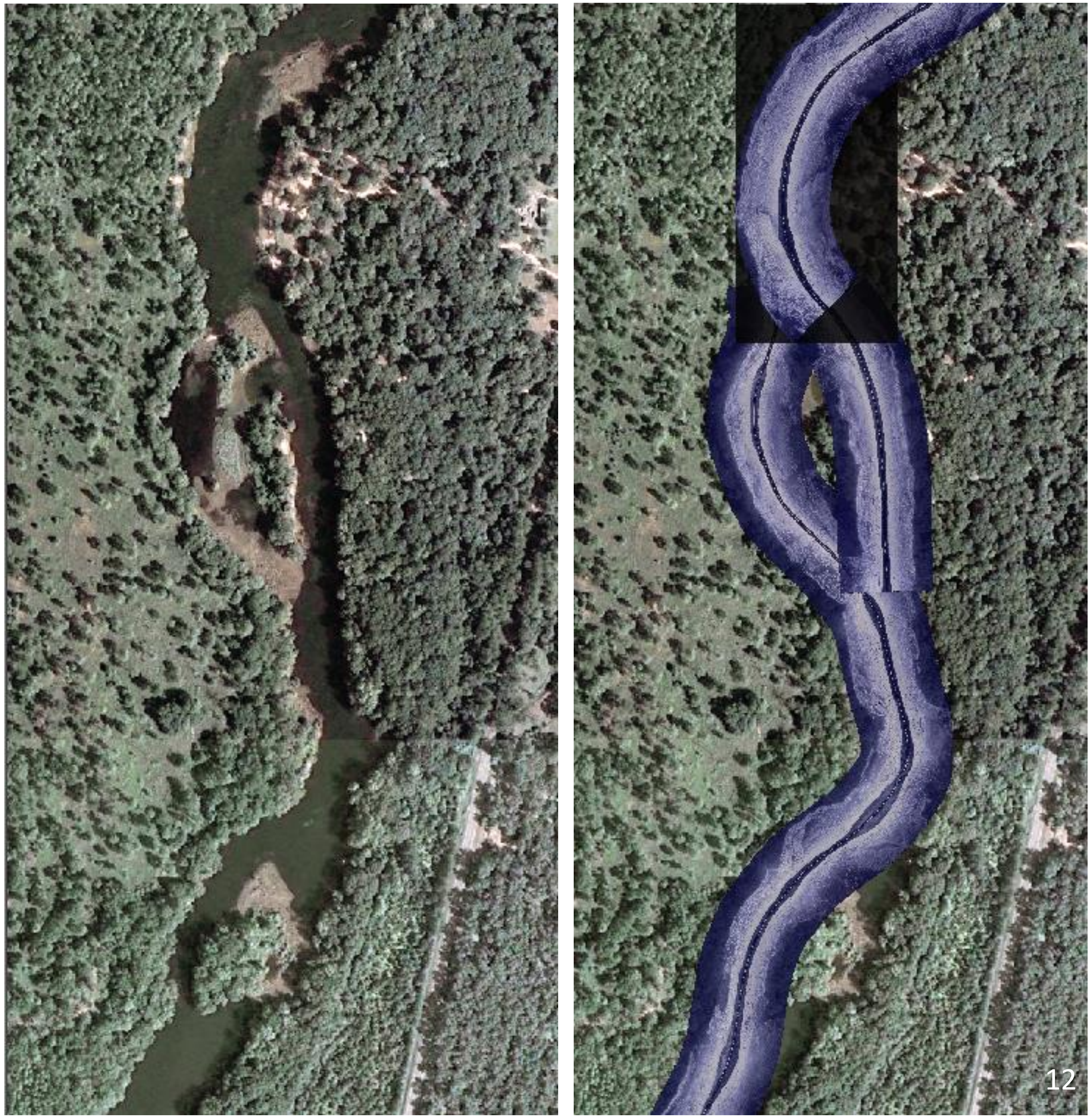
When conditions permit, a second pass can be made to image portions of the channel that are obstructed by islands or other features. The image shown here depicts a reach of the lower Flint River during extreme low flow conditions. Higher flows during our sonar survey permitted us to navigate the secondary channel formed by one of the islands.

Using Multiple Passes

Using multiple passes

Imagery captured during the two passes will ultimately be processed as two separate survey segments, and the rectified sonar image map layers can be displayed in a GIS as overlays. When interpreting and digitizing habitat features from overlapping image layers, it is possible to make one semi-transparent, to toggle the overlapping layers on and off, or simply move the better of the two layers to the top to facilitate interpretation of features in overlapping portions of the mosaic.

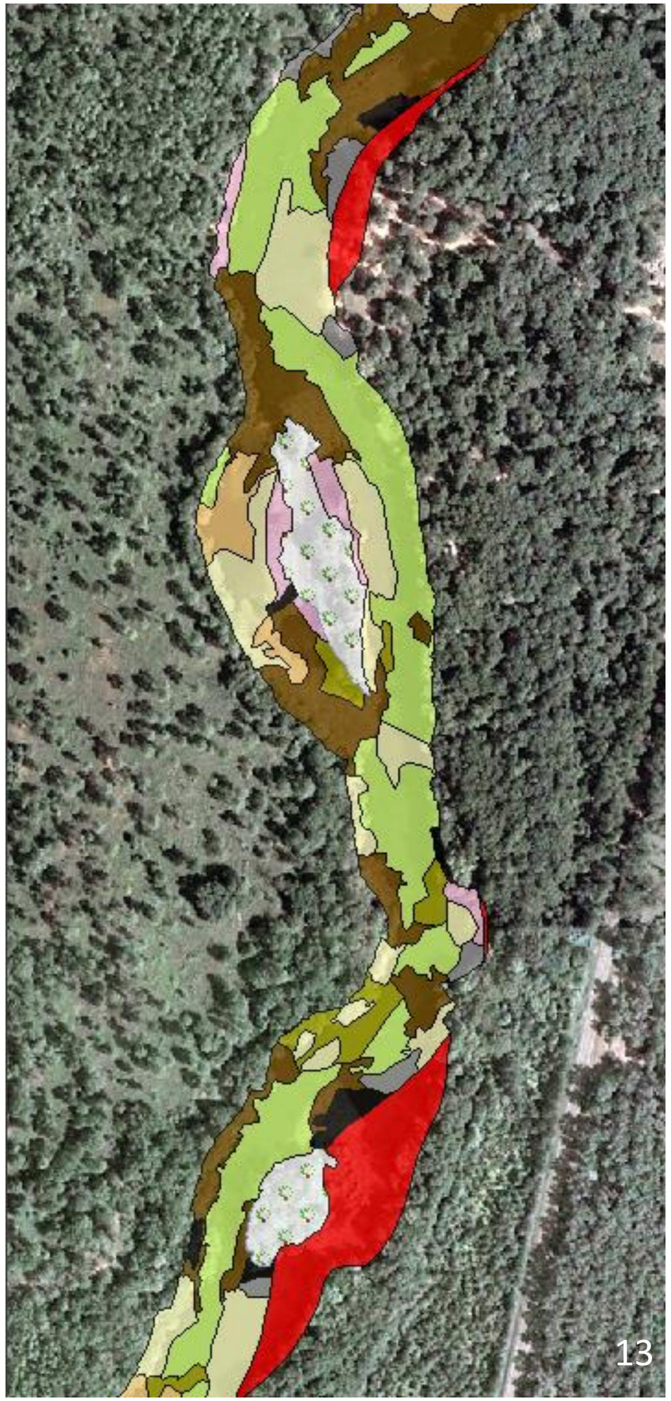
Using Multiple Passes



Using multiple passes

Once digitization and classification is complete, the classified substrate layer can be displayed and the sonar image layers removed. Here we see digitized polygons representing each substrate class in the classification scheme. Polygons representing the two islands, areas that were hidden by sonar shadow (black polygons), and areas not imaged because they were beyond sonar range (red polygons) are also represented in this map layer.

Using Multiple Passes



How shallow?

What is the minimum depth at which surveys can be conducted? Obviously, enough water must be present to permit unimpeded navigation using some mechanism for forward propulsion.

Minimum System Depth

Limited by depth required for navigation

…but surveys do not necessarily require a johnboat

- **Other possibilities- gheenoe, kayak?**

Johnboat with 30 HP motor

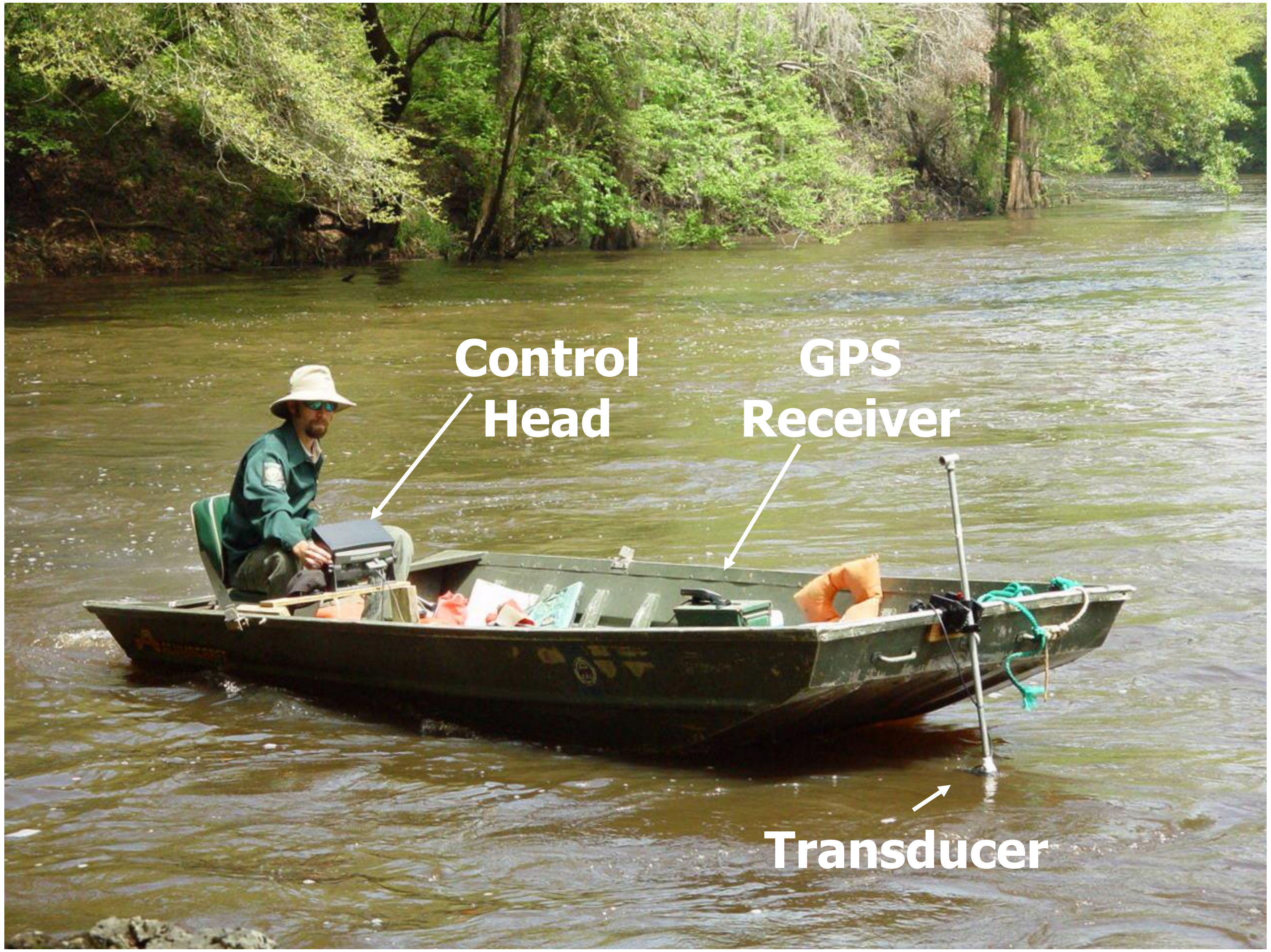
In flowing waters, a source of propulsion (thrust) is necessary to maintain heading, position, and speed. Propulsion is also essential to avoid the many dangers lurking beneath murky waters.

This 14-foot, lightweight johnboat proved to be very effective for sonar mapping in most of the creeks and rivers of Southwest Georgia. With the use of a roller trailer (trailer with rolling supports) it was possible for one person to launch this boat off a steep bank, whenever ramps were unavailable. I found the flat bottom of this boat ideal for stability on the water, a feature that supports the production of high quality imagery.

As you can see, it doesn't take much boat to get the job done. The control head is close at hand should the order to abandon ship be delivered.

*The position of the transducer is somewhat misleading in this photograph. It appears to be only and inch or two below the waters surface. In reality, I had a crew member on board who sat in front of this boat, adding weight and stability to the bow, ensuring that the transducer was actually deployed about 6 inches below the surface. This crew member was left on the bank to take this picture.

Survey Watercraft



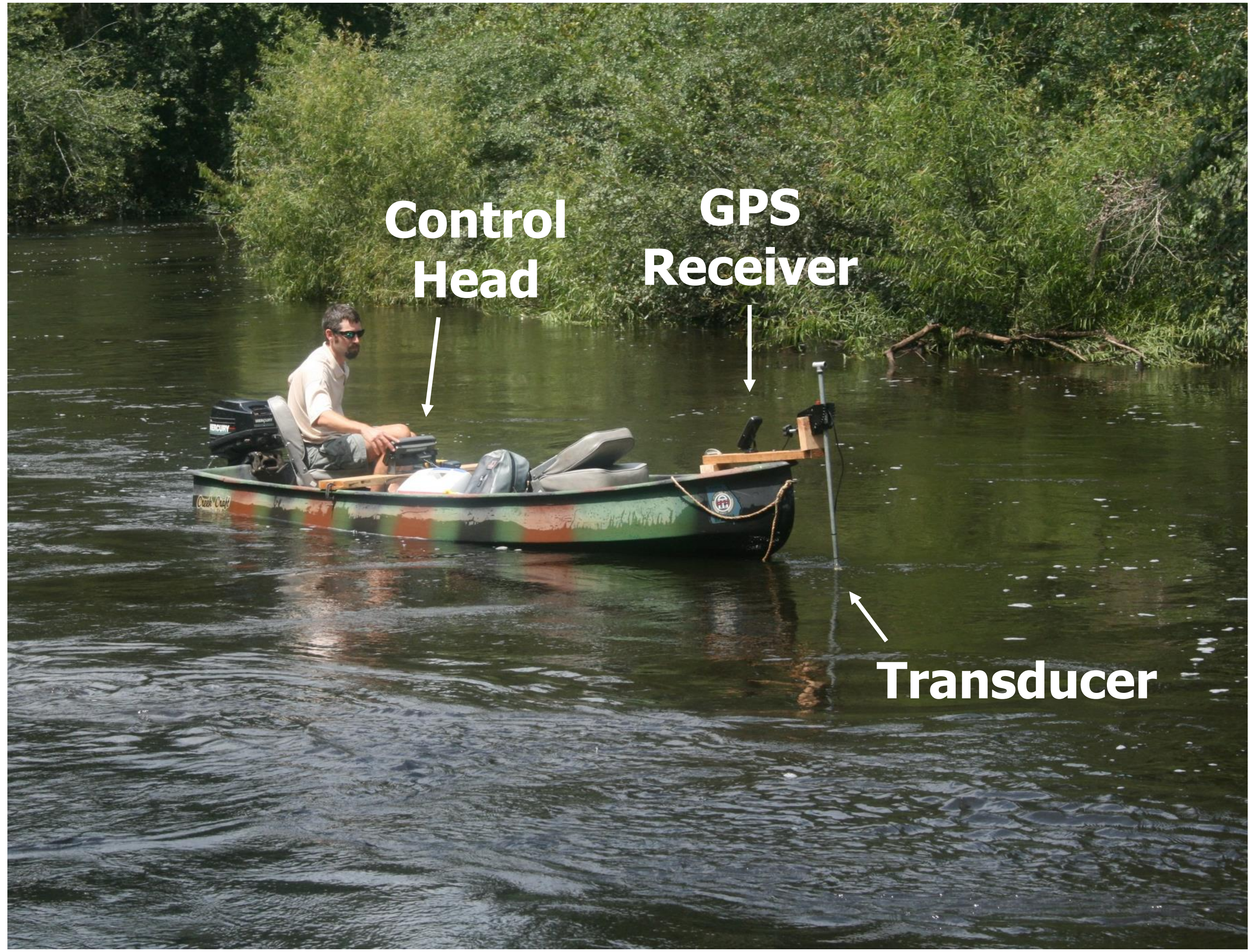
How small a boat?

In addition to a johnboat, we have successfully used smaller watercraft such as this powered gheenoe to conduct surveys.

If you find your watercraft lacks a square bow with a gunwhale for mounting a transducer rig do not despair! A little creativity in the workshop can go a long way- here we created a wooden arm to which the rig is attached.

We have not surveyed in high gradient reaches containing rapids or cascades, only streams that permit safe navigation during the appropriate flow conditions. Is it possible, however, to use non-motorized watercraft like kayaks, canoes, or rafts to survey such areas? Perhaps- but we cannot speak from experience. The challenge of maintaining heading, course, and speed is, however, magnified in a flowing system when using manual propulsion (i.e., paddling).

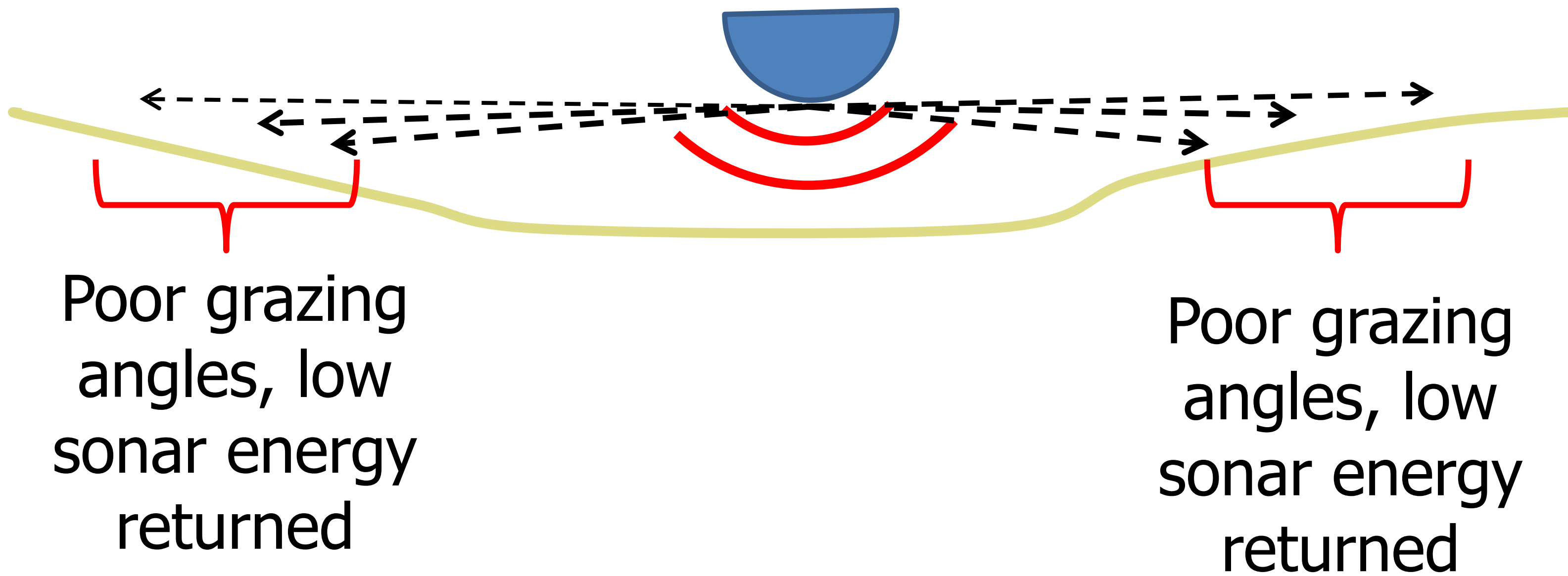
Using Smaller Watercraft



Shallow water limitations

When the depth beneath the transducer is shallow the grazing angles on distant portions of the channel are acute, returning low sonar energy to the transducer. Moreover, the signal is not being evenly distributed across the channel to image the surface. The result is sub-optimal image quality.

Shallow Water & Grazing Angles



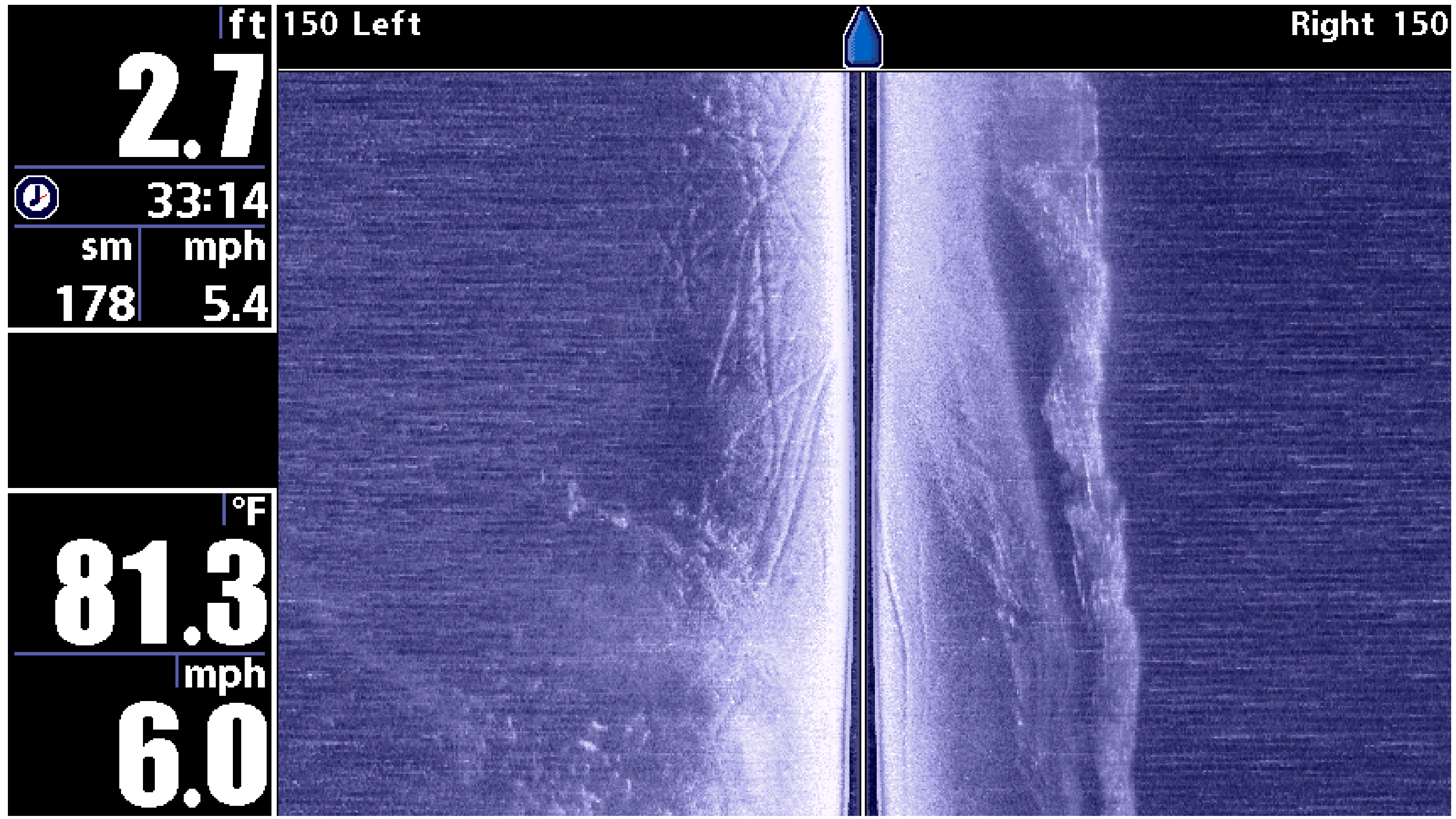
Shallow water limitations

Very shallow water typically hinders effective imaging of the entire channel. Although water depth along the boat track was <3 feet in this example, slightly deeper water was found to the right of the boat, and this part of the channel was imaged. To the left of the image we cannot see the actual river bank; a shallow sandbar occupied this area of the river channel. Notice the dark streaks along the left near the boat path. Any guess as to what caused these features?

I wasn't the only one having difficulty navigating through this flat.

It is interesting to note that the channel, or deepest water, appears to be on the far right hand side of the image, along the bank. The shadow cast by the sandbar suggests a drop off, or slightly deeper channel along the river margin.

Shallow Water Example



How deep is too deep?

According to the manual, the HB 1198c SI has a "typical depth performance of 150 feet at 455 kHz". We find this statement somewhat confusing and misleading. However, if we substitute the word range for depth, the statement begins to make a lot more sense.

To clarify, let's revisit some of the concepts we reviewed in Session I on the effects of range on image resolution. Imaging deep environments is much like imaging wide environments. For example, a range setting of at least 50 feet per side must be used in order to "reach" the bottom in a 50-foot hole. Clearly we must use a range setting of greater than 50 feet per side to image of the bottom of the hole. As range setting is increased, image resolution decreases as a result of beam spreading, and with greater depth beneath the transducer, slant range distortion in the near-field portion of imagery also increases due to compression.

Maximum System Depth

HB 997c has a "typical ~~depth~~ performance of 150 feet at 455 kHz" (Humminbird 997 Manual).

range

Effects on image resolution: imaging deep environments is like imaging wide environments- range must increase

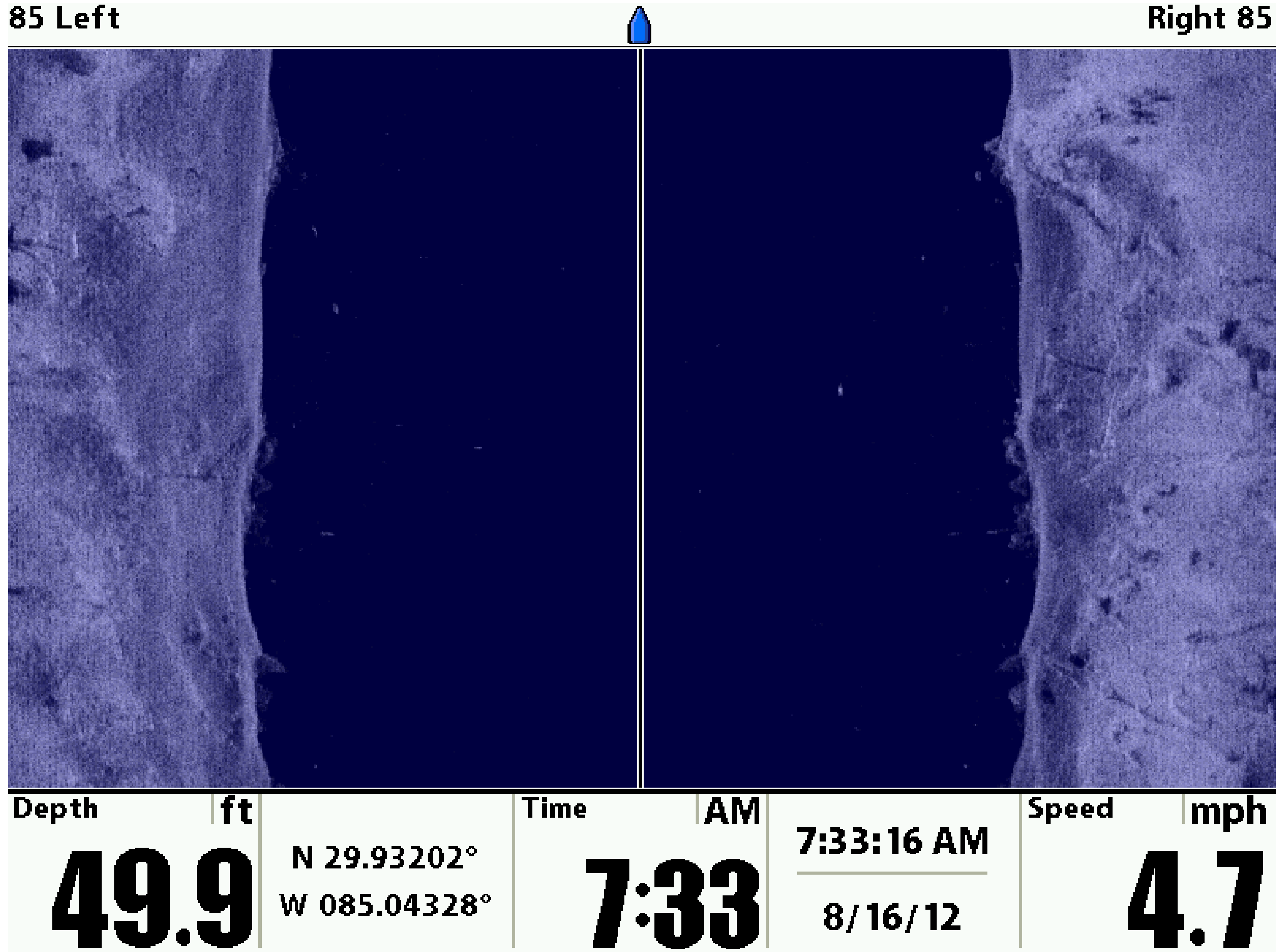
- Increased beam spreading= decreased resolution, ability to separate targets
- More slant range distortion in near-field
- For these reasons, towfish are used in deep water SSS applications

How deep is too deep?

Let's examine a case where a range setting of 85 feet per side was used to scan a 50 foot deep hole. In the raw sonar image shown here, >50% of either side of the image is occupied by the water column, leaving the remaining image pixel space available for representation of all of the river bottom that actually exists within this 170 foot swath. In other words, all of the bottom information is compressed into the region of the image not occupied by the water column. Obviously, objects and features will appear much smaller in this image than they would in a shallower area. Furthermore, the spatial position of features in this image are also skewed dramatically making the job of interpretation quite difficult.

There are a couple options for improving imagery when scanning deep areas. The first is to consider using higher range settings. There are negatives to this approach, as we have discussed. As the manual suggests, 150 feet per side is the approximate upper limit for performance when using 455 kHz. Another option is to employ a towfish. The towfish essentially lowers the transducer closer to the bottom, enabling the use of lower range settings for higher resolution in deeper environments. All else being equal, if we had used a towfish flown 25 feet beneath the boat in the example shown here, we would have reduced the water column area and the effect of compression by 50%.

Maximum System Depth



Information available

If interested in purchasing or building a towfish for the Humminbird system, you may find useful information on the internet at the side imaging forums. The photos of towfish shown here were obtained from these websites. The "tank" was a for-sale towfish, and the yellow fish was homemade. Humminbird sells an extension cable to lengthen the line between the control head and the transducer.

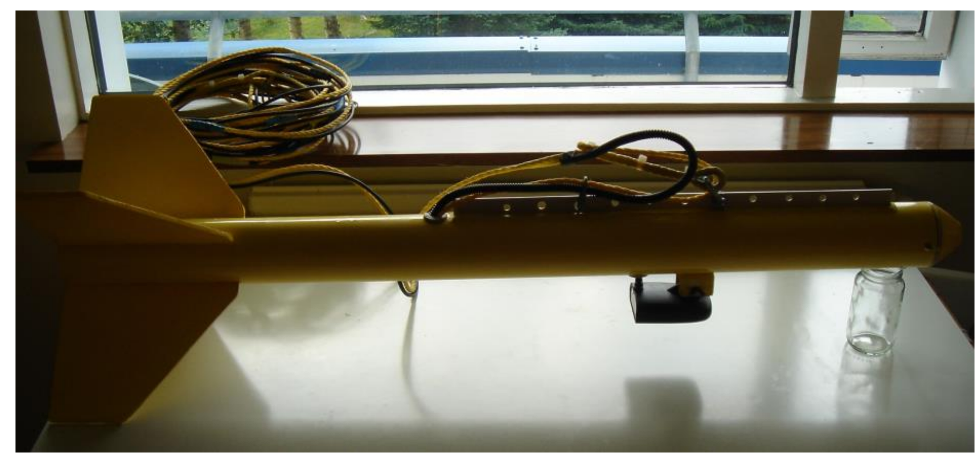
We do not have experience working with the Humminbird system and a towfish, mostly because our survey systems are generally not deep enough to warrant this type of deployment.

Towfish for Humminbird SI?

Humminbird Side Imaging Forums

http://forums.sideimagingsoft.com/index.php

http://www.xumba.scholleco.com/

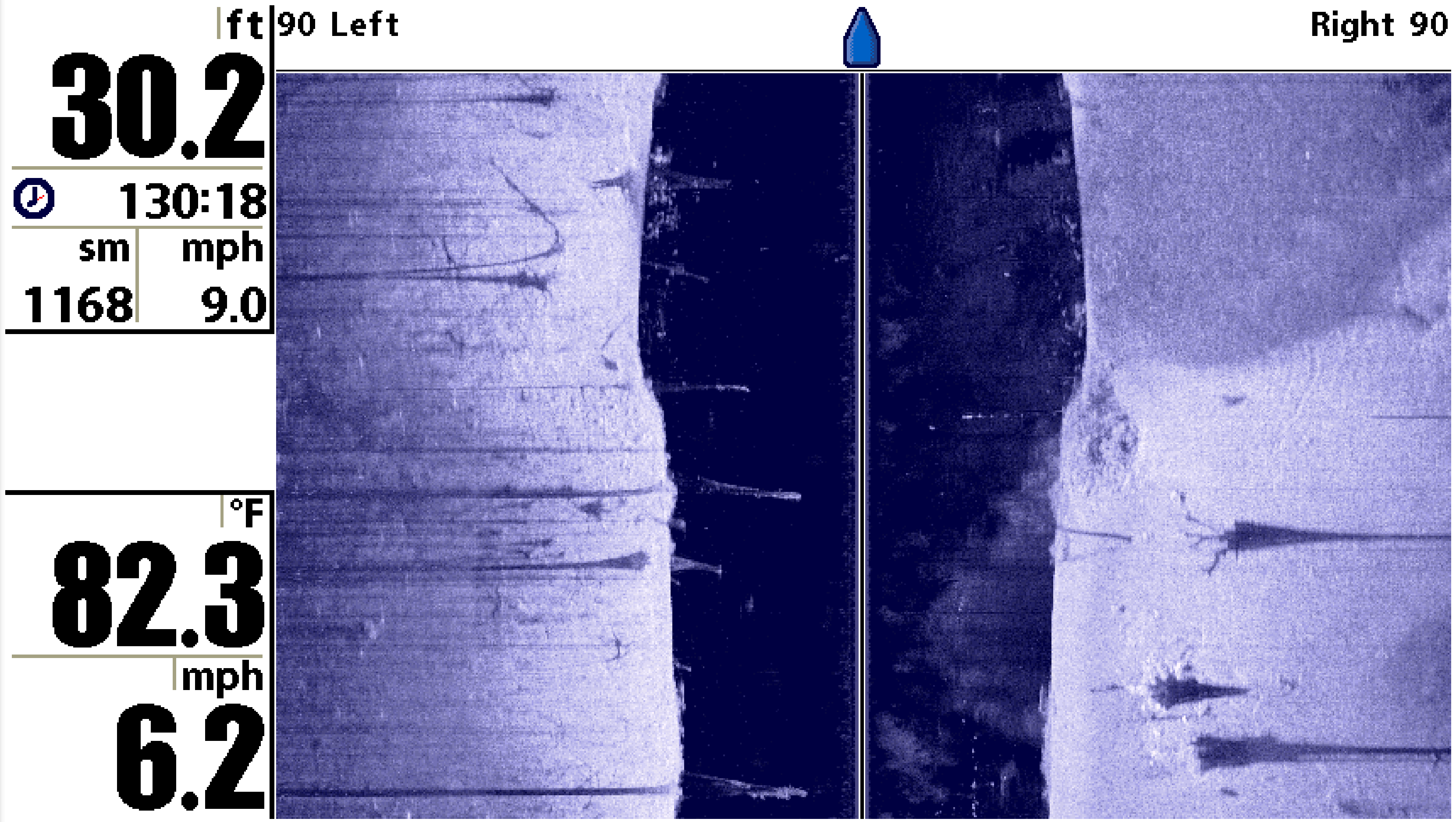


Where to fly the fish?

Even if you have a towfish, there will be waters that may be too treacherous for its deployment. Consider the image on the right captured in a local reservoir. This is an area of flooded, standing timber. Some of the snags are very close to the surface; it would only be a matter of time before the towfish crashed into a tree.

A Towfish Dilemma

Hidden, submerged hazards



Optimal depth:range ratio

Let's wrap up our discussion of depth and range by introducing a very useful rule of thumb for identifying the optimal depth-to-range ratio for side scan imaging. All else being equal, the best imaging results are obtained when depth (i.e., transducer altitude or height above the bottom) is approximately 10-20% of the range setting used during imaging. This very practical rule is one that all side scan operators should memorize and fully understand.

For several mapping studies, we estimated the average transducer altitude by dividing the average depth observed during the survey by the range. We have been very pleased with image quality produced when average depths ranged between 8.5-12.5% of the range, and prefer to operate at this lower end of the scale.

Let's discuss some implications and how to use the rule in practice. As mentioned, the upper limit for range performance at the 455 kHz frequency is ~150 feet per side. If using a fixed, bow-mounted transducer, the rule suggests that average depth in the survey system should run 15 to 30 feet. So, if depths in a target system typically exceed 30 feet, one should consider using a towfish if possible. Conversely, if average, mid-channel depth in the river is less than 12 feet (~8% of range) on the date of the survey, we would suggest using lower ranges and multiple, parallel transects to maintain high quality imagery, or choosing to survey at a higher flow (stage).

Transducer altitude:range Rule of Thumb

*Useful for evaluating range settings

Optimal transducer altitude for side imaging (**#1** in figure) is 10-20% of selected range setting

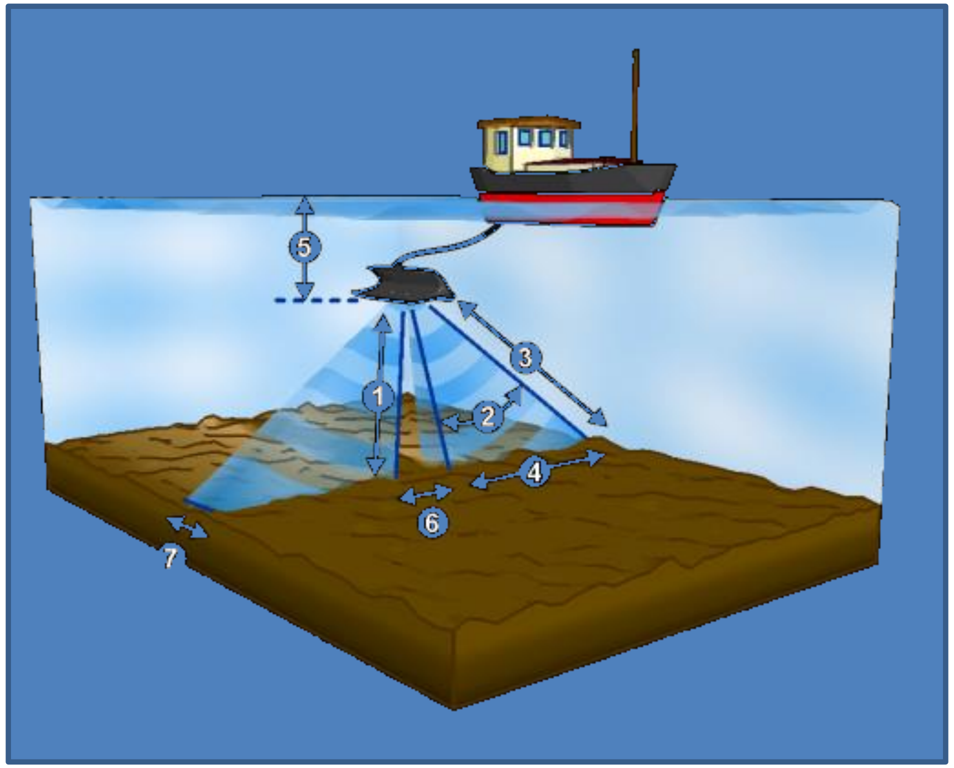


*Image obtained from: http://www.starfishsonar.com/images/technology/howitworks.png

How deep should it be?

Finally, let's test your understanding of the rule in a real-world, practice scenario. The state Fisheries Chief asks you to scan the Lazy River, a waterway popular with the locals for float tubing during the heat of summer. The river contains a limited amount of rocky habitat that is preferred by the critically endangered Lazy darter, a baitfish prized for its flashy colors; your objective is to map and quantify this habitat. You start planning by making several random measurements of the width of the Lazy River and find that it averages 150 wide. You would prefer to scan the entire wetted channel of the river using only one pass. After all, this is the *Lazy* River. You figure a range setting of 85 feet per side (170 foot swath) should be used to account for natural changes in width that occur in the study reach. Given the rule of thumb, what range of depths would provide the optimal imaging environment on the day of the survey?

According to the rule, the answer is 8.5 to 17 feet of depth on average. We would suggest, however, that average depths of ~7 feet should be adequate for quality imagery.

If you are unfamiliar with the flow and depth relationship on the Lazy River, you might have to do some prospecting to determine which flow provides 7 feet of water on average beneath the boat. If the Lazy River remains in drought all year and never exceeds 4 feet deep, you might have to redesign your survey using lower range settings and multiple, parallel passes.

Transducer altitude:range Rule of Thumb

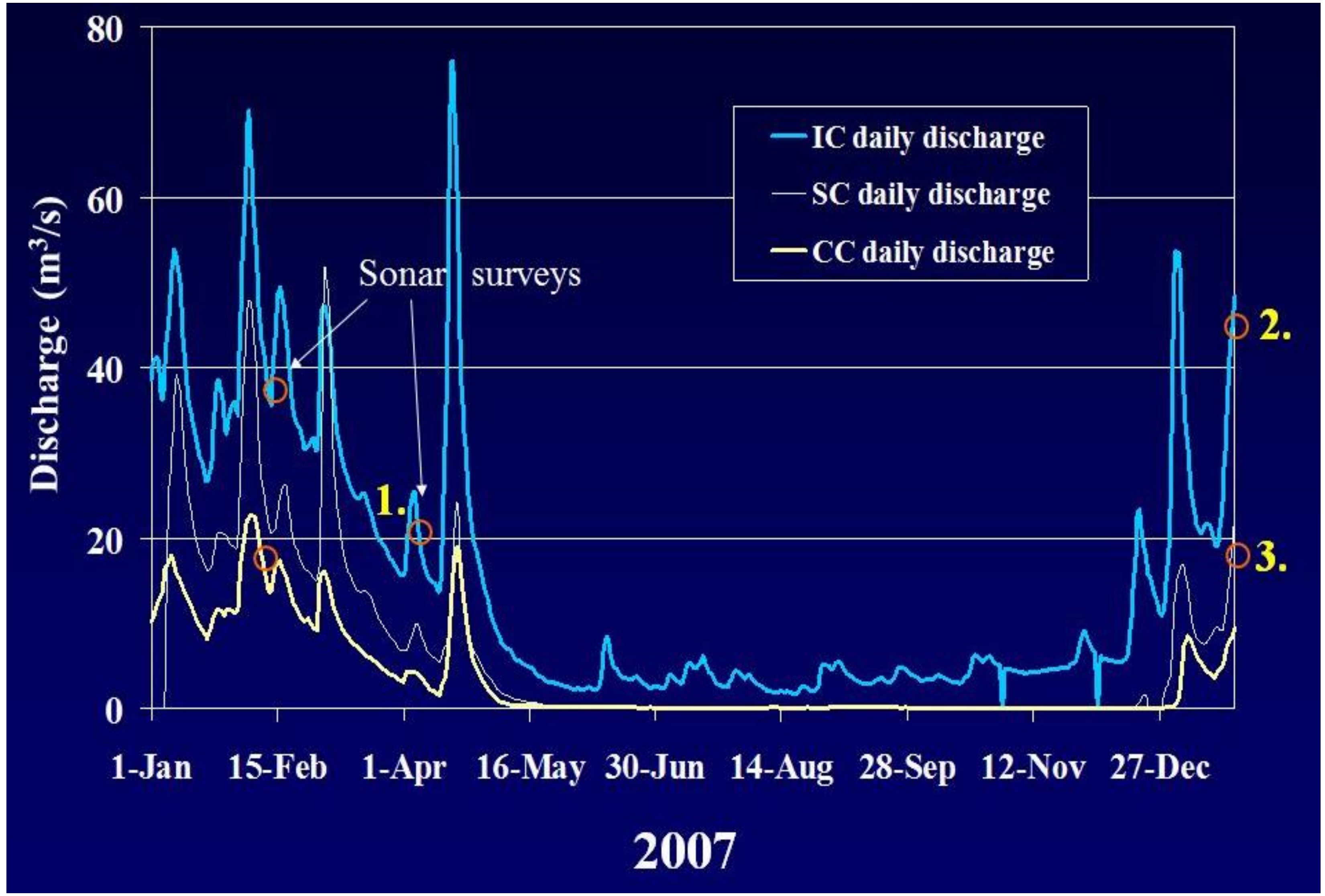
Scenario: I want to scan the Lazy River which averages 150 feet wide. I plan to image the whole channel in one pass, using a range of 85 feet per side.

What range of depths would provide the most optimal imaging environment according to the rule of thumb?

Timing is very important

When scanning rivers and streams it is critical to pay attention to discharge, and consider the effects that variable discharge may have on the imaging environment of the system. On the right we have prepared a hydrograph for 3 creeks we surveyed in Southwest Georgia in the year 2007. Discharge varied considerably over the year, with drought impacting flows during the summer. The orange circles identify dates when sonar surveys were attempted on each stream. Points 1 (early April) and 2 (late January) represent surveys during very different levels of discharge on Ichawaynochaway Creek (IC).

When to survey?



Best timing or not?

It pays to study the hydrologic record (if available) for your target system with respect to trends in precipitation (wet vs. dry years) and rates of change in flow relative to precipitation events. It also pays to watch the weather and keep a flexible schedule during the sonar scanning season. In this example, we found ourselves in a predicament. The month of April was typically the last month to expect any significant high flow events- and we needed to execute the survey on this stream during a high water event. Concerned that the early April runoff event might be last, we headed to the field on the 6th and scanned a portion of the creek. You can see from this photograph that the entire channel was not inundated at this flow. Note the exposed substrate in front of the cypress tress to the left. Bankfull flows, which inundate the entire stream channel, typically submerge the bases of cypress trees and their knees along the stream bank. This flow was not optimal, and because we failed to image all of the channel in several places we decided to try again at a higher flow. As fate would have it, a good high flow event occurred just weeks later (the last runoff event of the season), but we had work conflicts and could not get to the field. Then a significant drought ensued. The resurvey would have to wait until high water returned to Ichawaynochaway Creek.

Point 1. Ichawaynochaway Creek

April 6, 2007 – below bankfull discharge

Full inundation

The following winter we returned to Ichawaynochaway Creek during a high flow event exceeding 40 cms. The photograph on the right depicts the creek on the date of the resurvey work. Clearly these flows fully inundated the entire stream channel and provided us the opportunity to scan the whole creek using a single downstream pass.

Point 2. Ichawaynochaway Creek

January 21, 2008 ~Bankfull flow

Seize the opportunity

Conditions were so ideal for our resurvey work on Ichawaynochaway Creek that we decided to return to the field the next day and survey a nearby stream called Spring Creek. This stream was experiencing a similar runoff event triggered by rains that had fallen in both watersheds. Note that the water level is above the base of the cypress trees along the bank.

Point 3. Spring Creek

January 22, 2008 ~Bankfull flow

Is width a limiting factor?

We have worked in some small creeks, and in some fairly large Coastal Plain rivers (e.g., Apalachicola River (FL) and Altamaha River (GA)) using multiple parallel passes to maintain high image resolution. In very narrow streams, navigation may be an issue due to shallow water, steep gradient, or high sinuosity. We are curious to see what might result from the use of a kayak with a lightweight marine battery and using sonar recordings rather than snapshots to free up the hands for paddling, but have not been faced with the need to explore this possibility.

In a mapping study on the lower Flint River we investigated the effects of increasing ranges on image resolution and map accuracy. Results indicated that ranges of ≤170 feet per side should be maintained when using 455 kHz to limit the amount of uncertainty in the classified substrate map. This recommendation is consistent with the Humminbird manual statement regarding 150 feet per side as the upper range performance limit at 455 kHz.

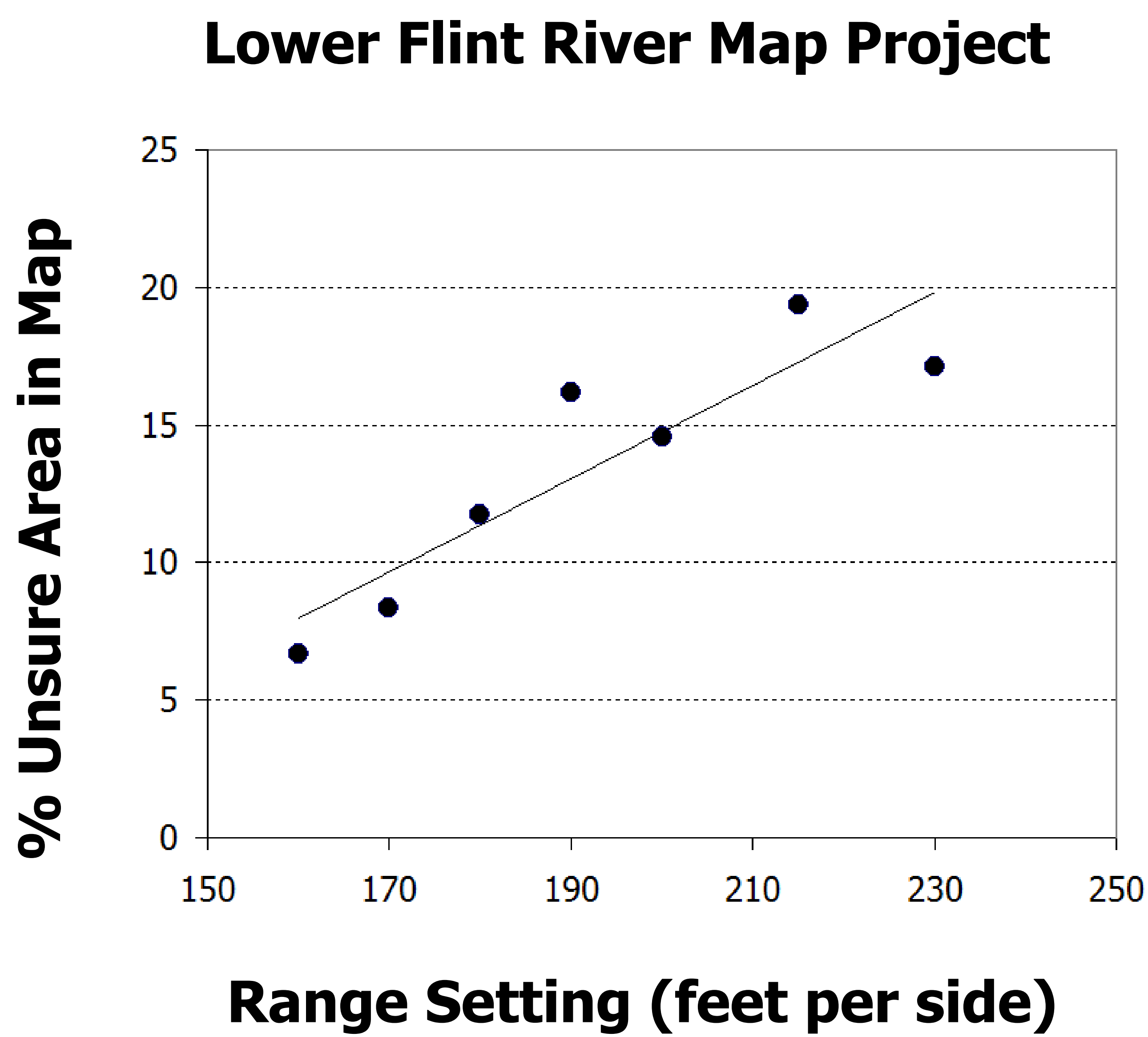
Maximum System Width

- **We have mapped rivers 20-350 m wide**
- **HB 997c SI max width setting is 120 m (360 feet) per side, or 240 m total width**
- **But remember as range increases, resolution decreases! In wide rivers, an alternative approach would be to make 2 or more passes.**
- **Our working rule of thumb- for <10% map uncertainty (image distortion) using 455 kHz, use ranges ≤ 170 ft per side (53 m/side). Thus, one-pass approach feasible in rivers up to 300 ft (100 m) wide.**

Range vs. map uncertainty

It should be very clear at this point that the range setting has global influence on the quality of sonar imagery and products that come from interpretation of the imagery. To further illustrate this point we have included one of the figures from Kaeser et al. (2012) illustrating the relationship between range setting and the areal proportion of the riverbed that was classified as "unsure" due to poor image quality along the river margins. This data set was used to identify the 170 foot threshold discussed in the previous slide.

Range Affects Map Uncertainty



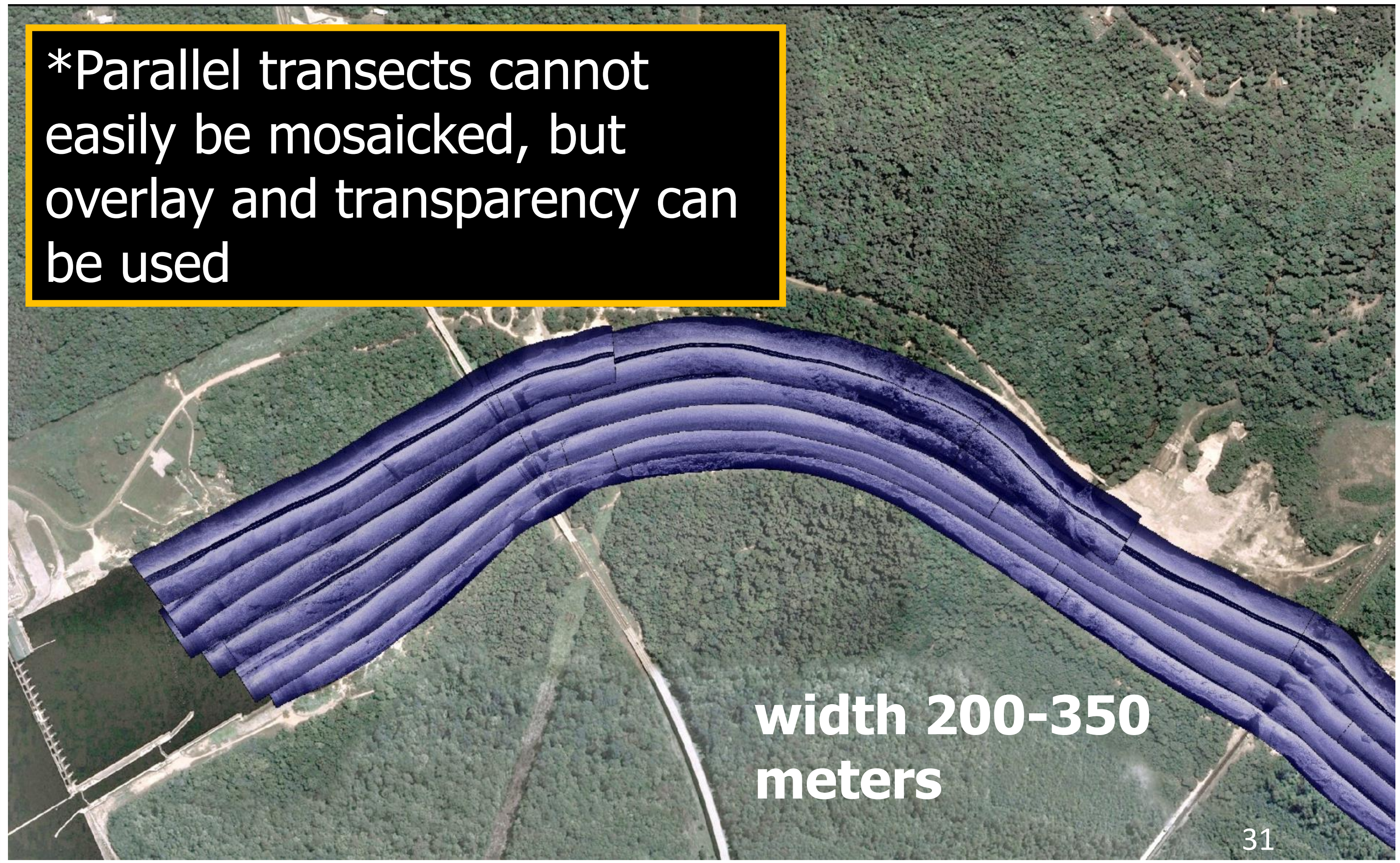
Multiple, parallel passes

When tackling a wide river, or any open expanse of water, it is best to adopt the approach often taken during offshore side scan surveys- multiple, parallel passes. The adjacent image provides an example of this approach in the headwaters of the Apalachicola River. Here we made 4-6 parallel passes to cover the full channel; passes were simply eyeballed in the field using feedback from the Garmin GPSmap screen to maintain a fixed distance from the previous pass. This work could have been done in a much more sophisticated manner with a little work in ArcGIS ahead of time to establish perfect, parallel navigation routes to follow in the field.

A popular question is whether parallel transects can be mosaicked together for a seamless image product. Although there are probably a few ways to mosaic parallel transects, we find it impractical to spend time doing so. When interpreting imagery in areas of image overlap, we simply overlay mosaics, or use transparency and the ability to turn mosaic layers on and off accordingly to digitize habitat features. After all, the sonar image maps are not the final products; they simply provide the foundation for the map layers we are interested in developing.

Using Multiple Passes to maintain high resolution

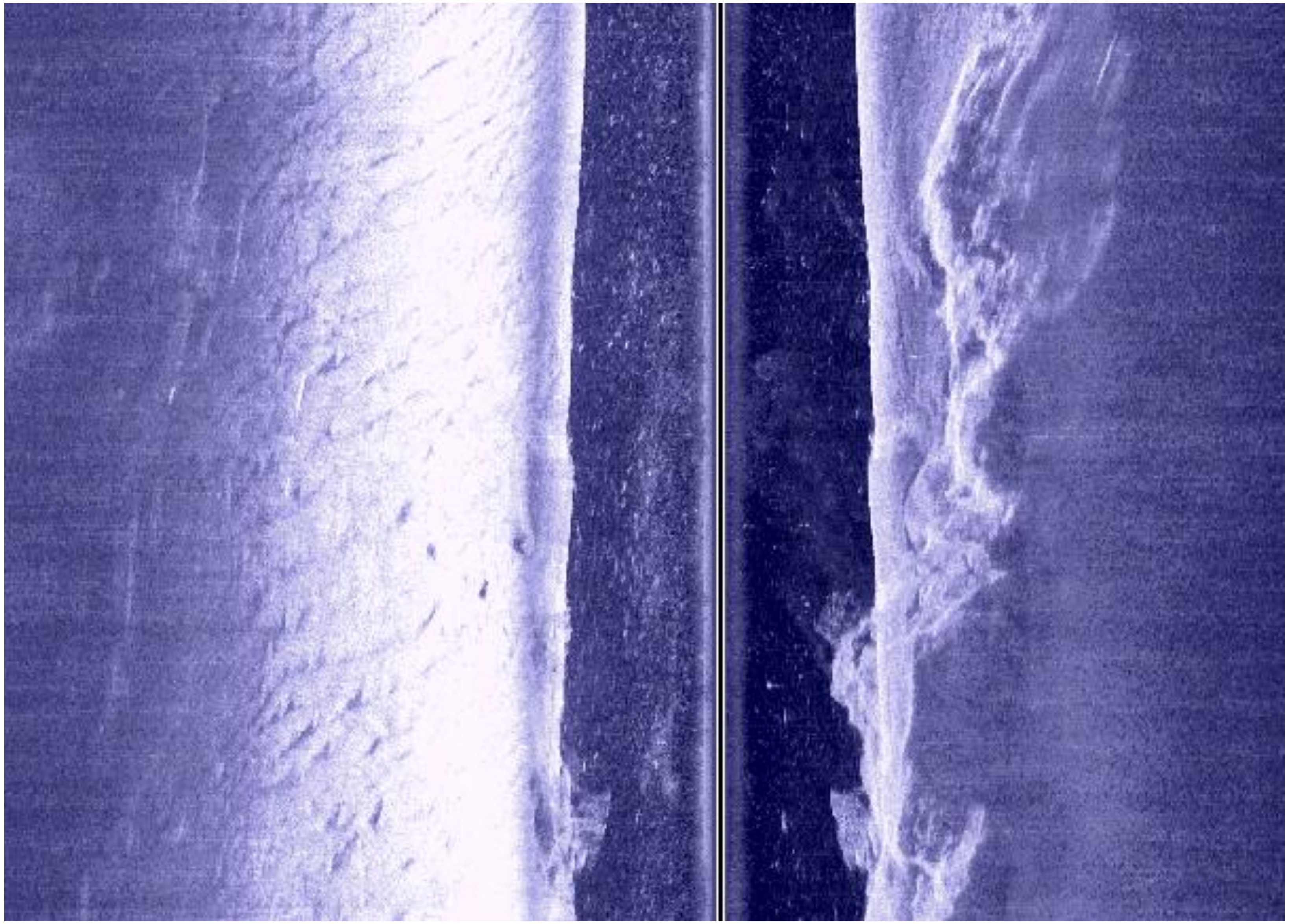
Head of the Apalachicola River



The devil in the debris

The best planning for sonar survey work should consider the impact of water column debris, a sneaky and troublesome issue that affects image quality. In the adjacent image you will find that the water column, especially on the left side, appears like the Milky Way galaxy on a dark night. This effect is due to the reflection, or scattering, of the sonar signal by innumerable submerged leaves and debris entrained in the water column.

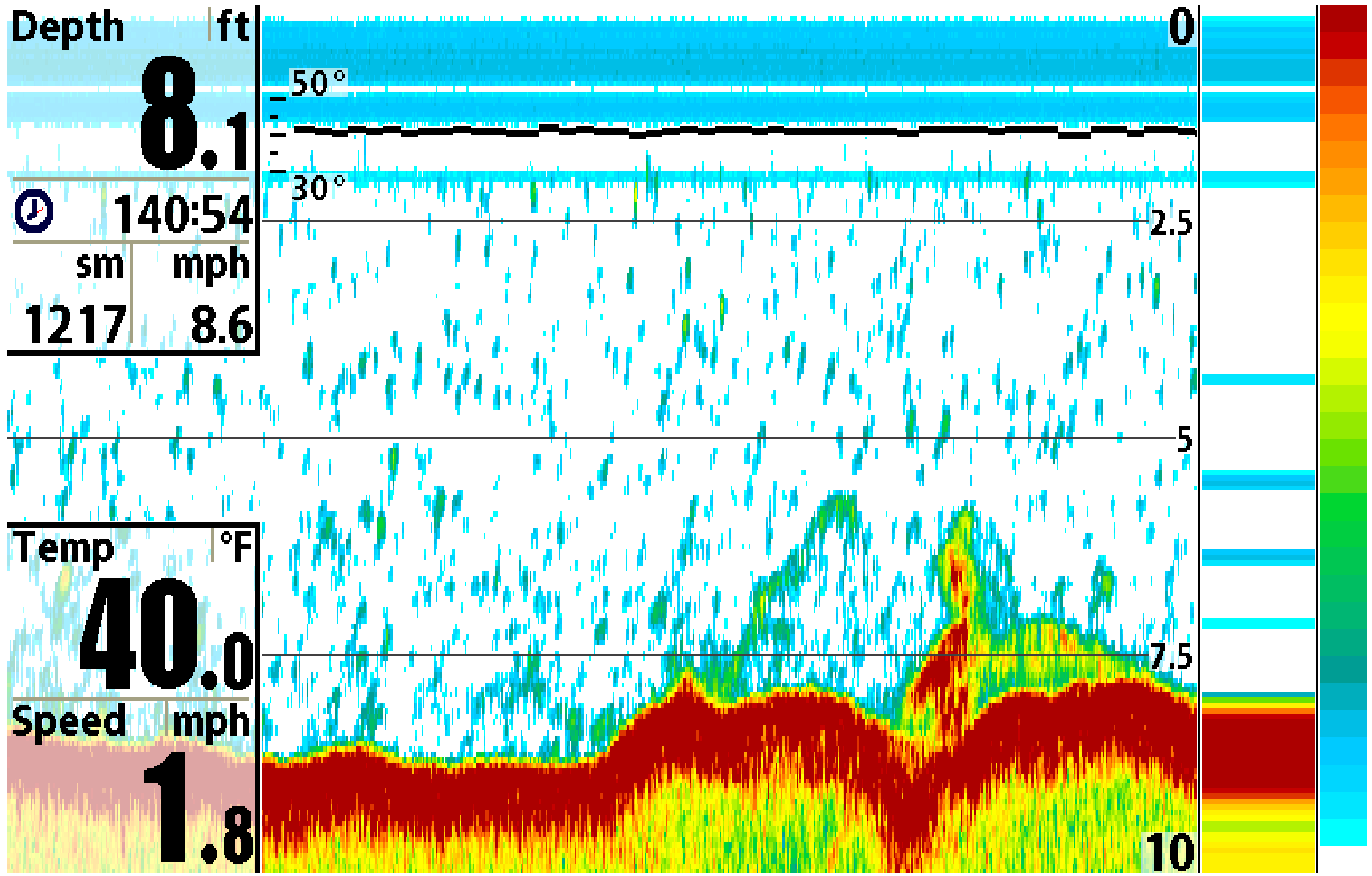
Water Column Debris



A look at what's below

Switching the control head display to the traditional, down-looking sonar view reveals a water column that is full of suspended, sound-scattering debris. This situation is indeed problematic because there isn't much that can be done operationally to control the impact of debris on image quality. By adjusting the sensitivity setting, some of the noise created by the scattering of signal might be reduced to improve image quality, yet we find it best to try to avoid this situation in the first place, if possible.

Water Column Debris



Ideas for avoiding debris

When it comes to producing the best possible imagery, there's no substitute for experience and attention to the dynamic imaging environment of a particular study system. In our experience with scanning creeks and rivers of the Southeast Coastal Plain, we have found that the first high water event of the wet season (which may not occur until January or February in some years) will often be associated with heavy volumes of suspended organic matter, particulary leaves that have been shed during Fall within the riparian zone of the stream and its feeder tributaries. We believe that best practices avoid scanning during the first few high water events that follow leaf drop; we prefer events that occur later in spring (March/April) for water carrying less debris.

We also prefer scanning during the falling limb of the hydrograph, rather than during rising water levels. In theory, rising water levels may be working to entrain debris along the banks. Pushing a large wake while running upriver might also have the same effect. It's difficult to know for sure if these effects are real, nonetheless we try to do everything in our power to scan during the most favorable imaging conditions.

Avoiding Debris

Do not plan sonar survey during first high water event of the wet season

-Rising water levels may entrain debris along bank

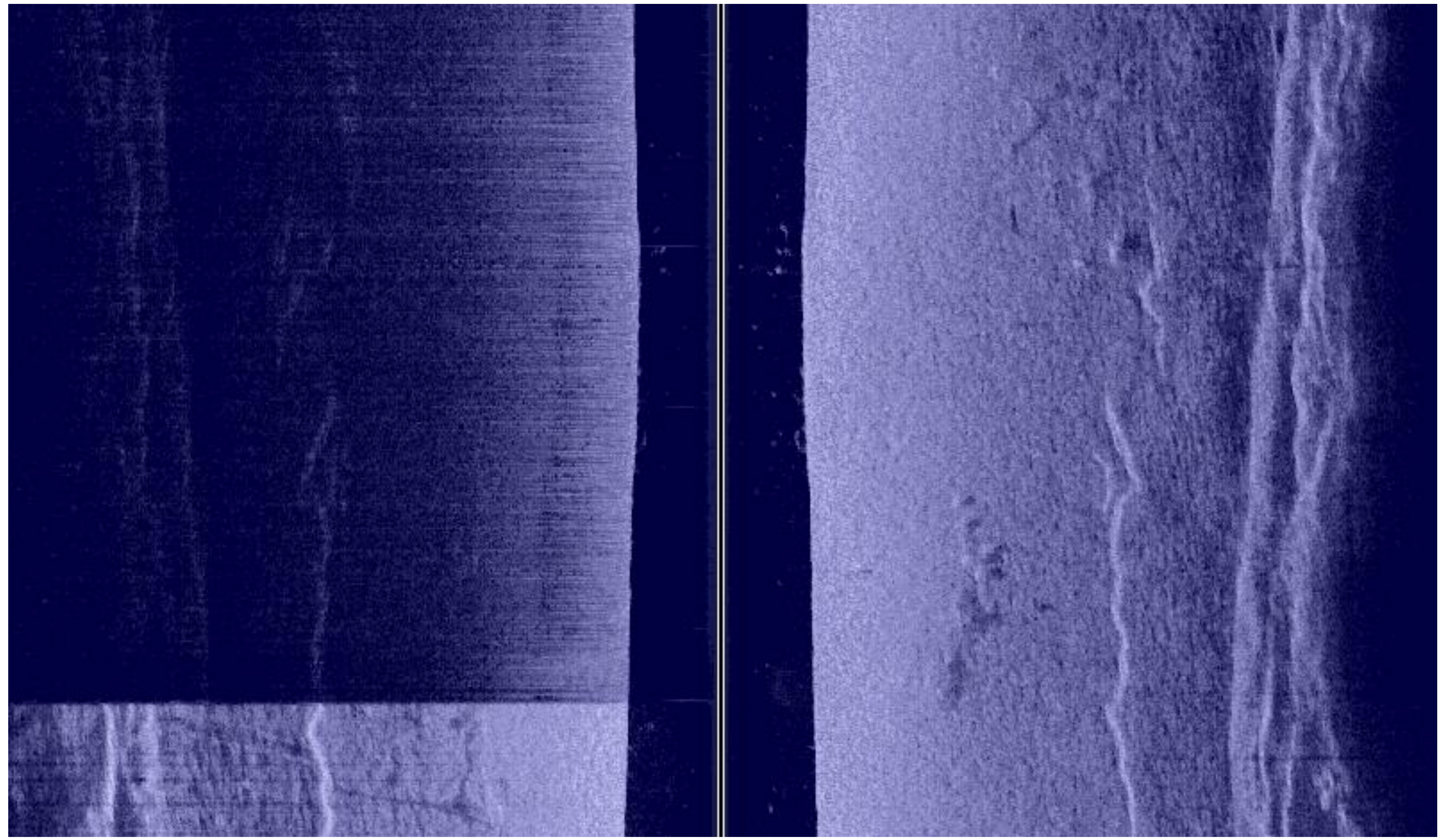
-Pushing a wake during an upstream run might also entrain debris

Changes in image quality

During a sonar survey, image quality can deteriorate. Changes may occur abruptly, as in the example to the right. Alternatively, image quality may slowly degrade over time. One of the responsibilities of the sonar operator is to continuously monitor image quality and act swiftly to correct problems. Let's consider the situation on the right. We see an abrupt and disturbing alteration in image quality on the left side of the image only. What on earth could be causing this problem? There are at least two common causes that should be immediately investigated. First, a leaf may have become impinged on the leading face of the transducer affecting signal transmission or reception on the left side only. The quick and immediate fix is, of course, to reach into the water a clear the debris from the transducer. Regardless of debris volume, the time will come when you catch a leaf on the transducer that must be cleared away. Sometimes the effect on image quality is immediate; other times, the effect appears slowly and almost imperceptibly over time. It pays to check the transducer regularly, and to pay attention to image quality.

A second potential explanation for this effect has to do with the electrical connections between the transducer and the control head. **We strongly recommend the use of the hard plastic harness** holding all of the cable plugs in place on the backside of the control head. In our experience, failure to use this harness leads to loosening of the contacts and subsequent electrical issues.

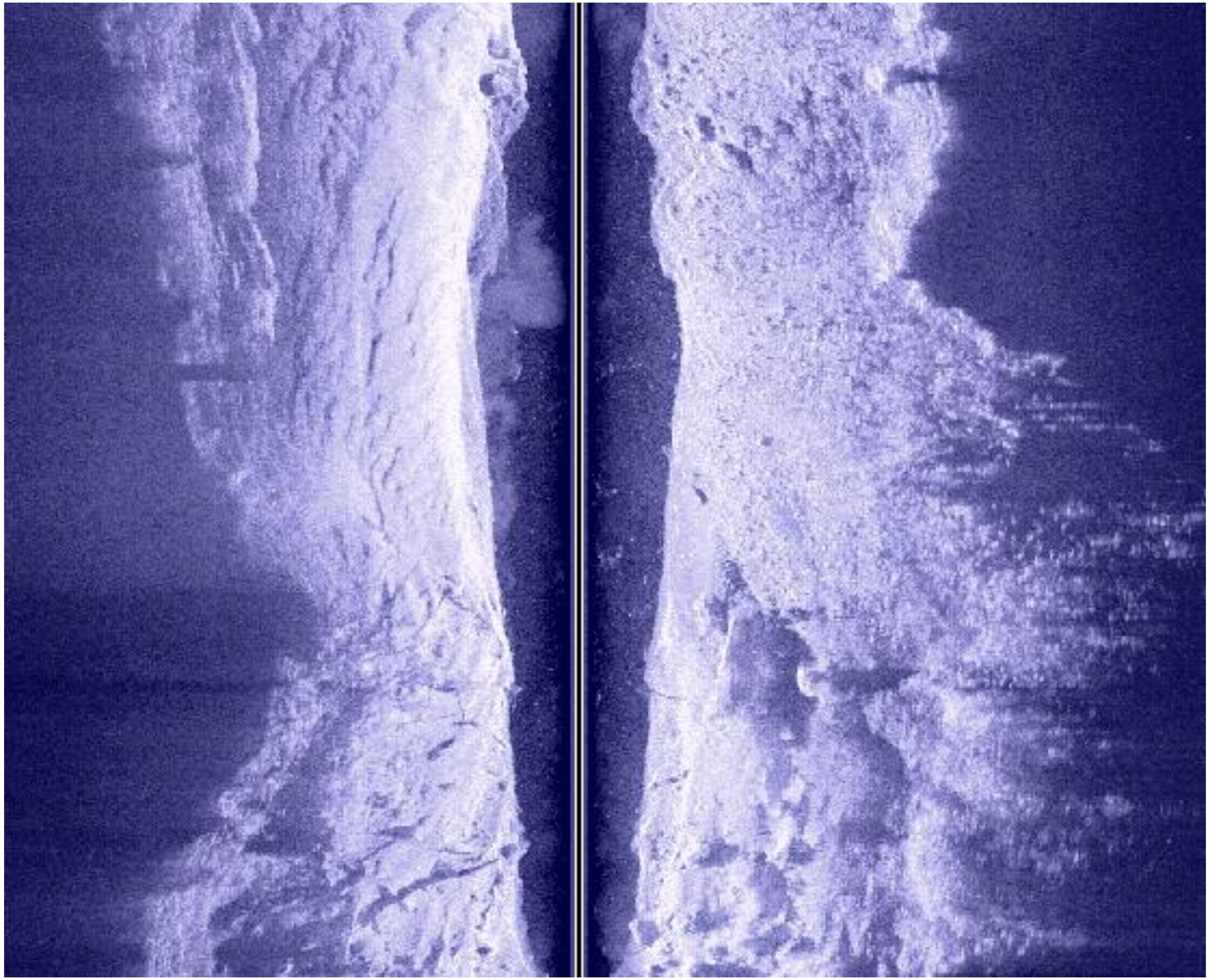
What's wrong with this image?



Turbulence affects quality

Turbulent flow can also have a negative effect on image quality. In the example on the right we see what appears to be plume of milky water within the left side of the water column. This effect is reminiscent of a plume of suspended sediment, however, the entire creek was incredibly muddy on the day this image was captured. This effect is actually a visualization of turbulent water column flow, rather than a sediment plume. The scattering of sound that occurs in a turbulent environment tends to degrade image quality to an extent. In this example, turbulent flow is being created where high water velocity intercepts deflecting structure.

Water Column Turbulence

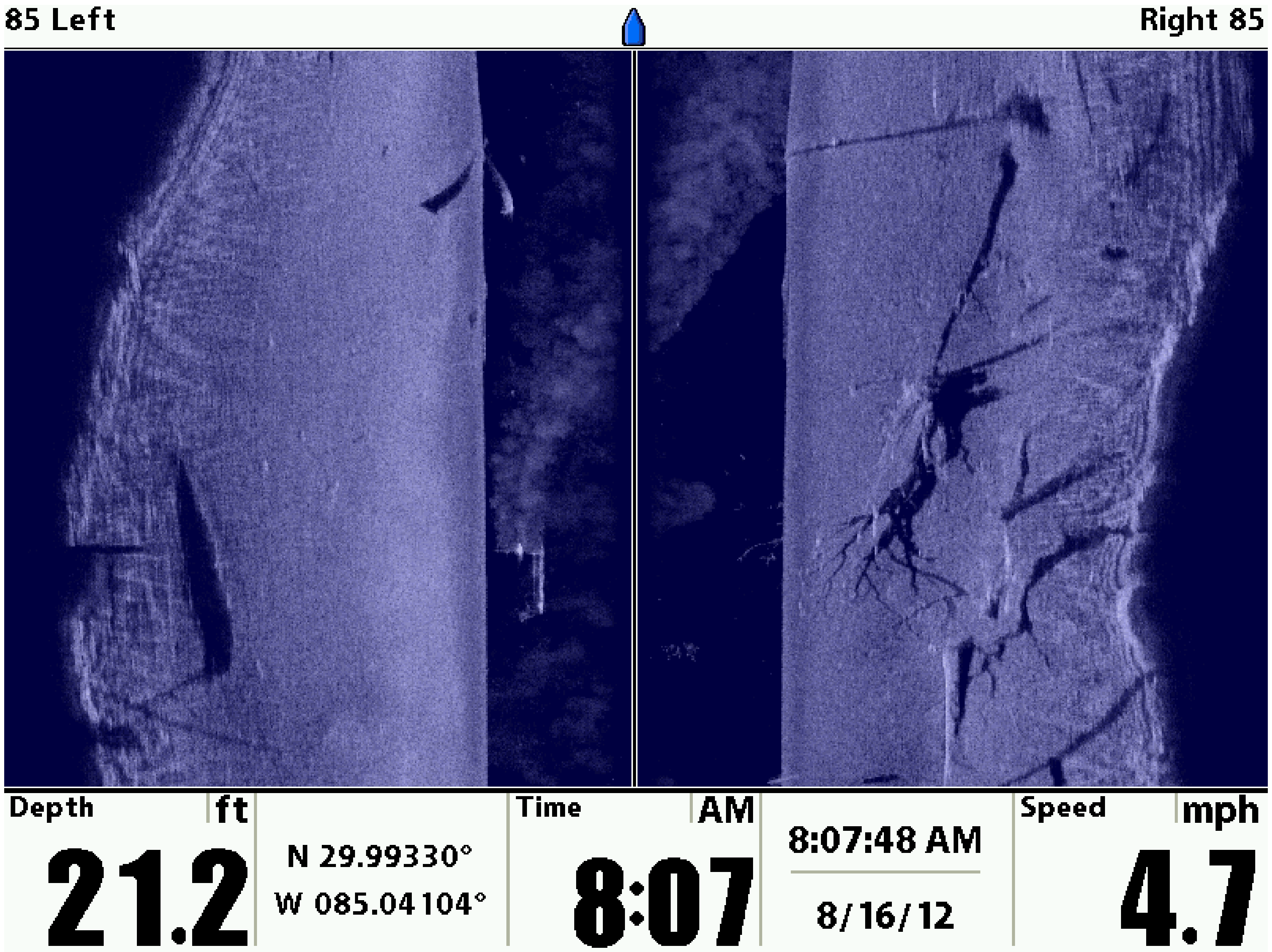


Prop wash

Another good example of turbulence includes the prop-wash of motorized watercraft. On the right, we slowly idled past another motorboat heading in the opposite direction. It's interesting to note that we imaged the boat's hull and the motor's lower unit, and can clearly see the trail of turbulence left behind.

The natural causes of turbulence in a sonar imaging environment may not be controllable. Smooth, laminar flow is best for imaging.

Water Column Turbulence

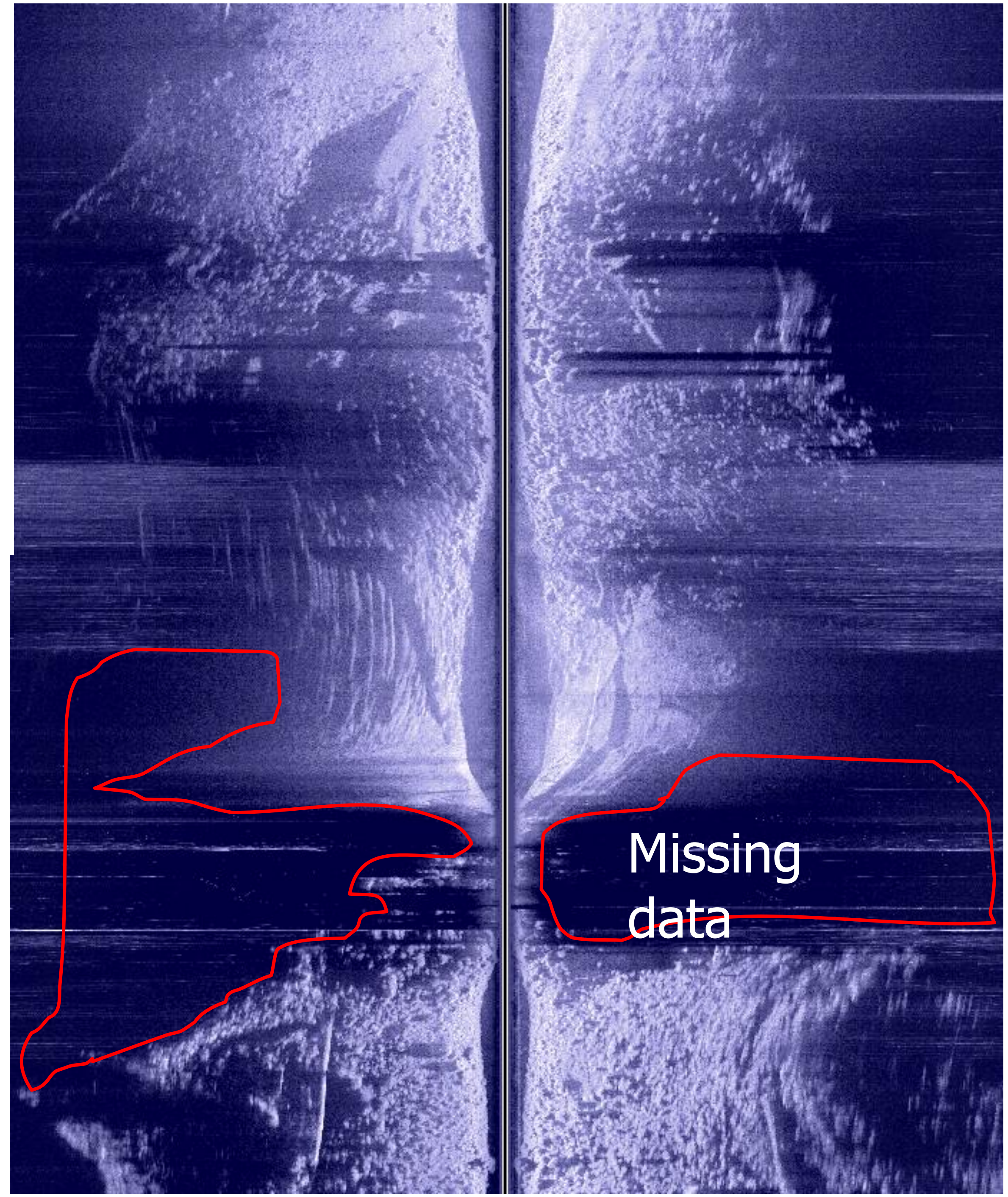


Imaging rough reaches

Here is a mosaic of raw sonar images captured during navigation through a set of treacherous shoals and rough water. The shallow rocks cast a lot of sonar shadow; between the outcrops turbulence has created some image wash-out. Despite these effects, there is still a lot of useful information contained in this mosaic. The shadowed areas can either be classified as missing data, or assigned a substrate classification with the aid of an air photo or field notes.

Note just how close the transducer came to striking the boulders in this reach! In 6 years we have never lost a transducer to a rock. Would you be willing to take these kind of calculated risks with a towfish and a $30,000+ sonar system? Confidence in the ability to scan a variety of systems and situations is a direct benefit of low-cost equipment.

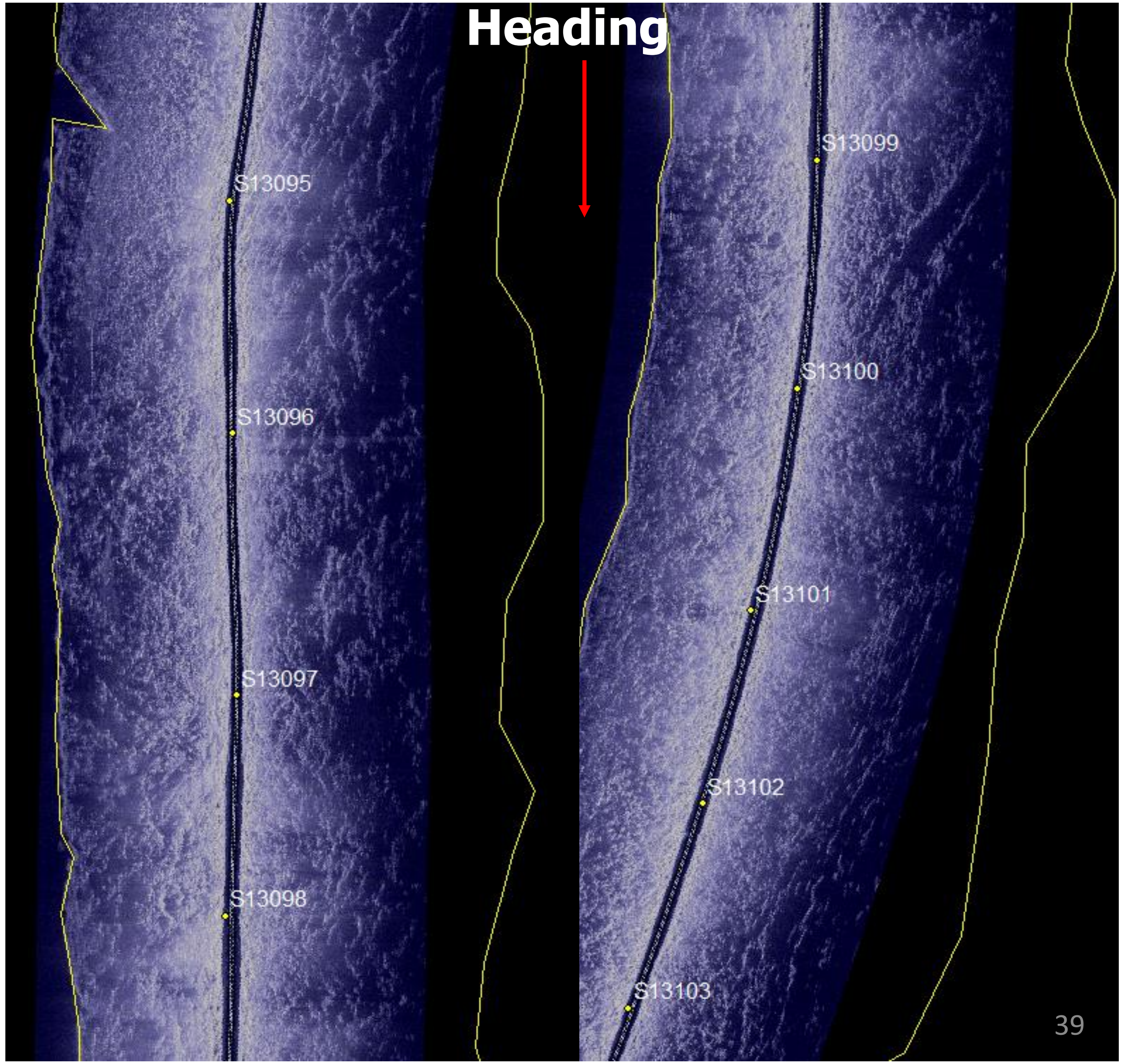
Navigating Heavy Shoals



Imaging rough reaches

The rectified mosaics shown here are the products of a perfectly-timed high water survey discussed in the geoprocessing workbook later used in this workshop. This shallow, rocky reach of the upper Flint River was extensive, and the right flow was essential for successful navigation. Despite the shallow depths of the channel relative to our range setting (see imagery on right) and the obvious water column turbulence, the resulting imagery is interpretable and thus useful. The motor's skeg did skip across the tops of several rocks in this reach, making for an exciting run!

Extensive Shoal Networks



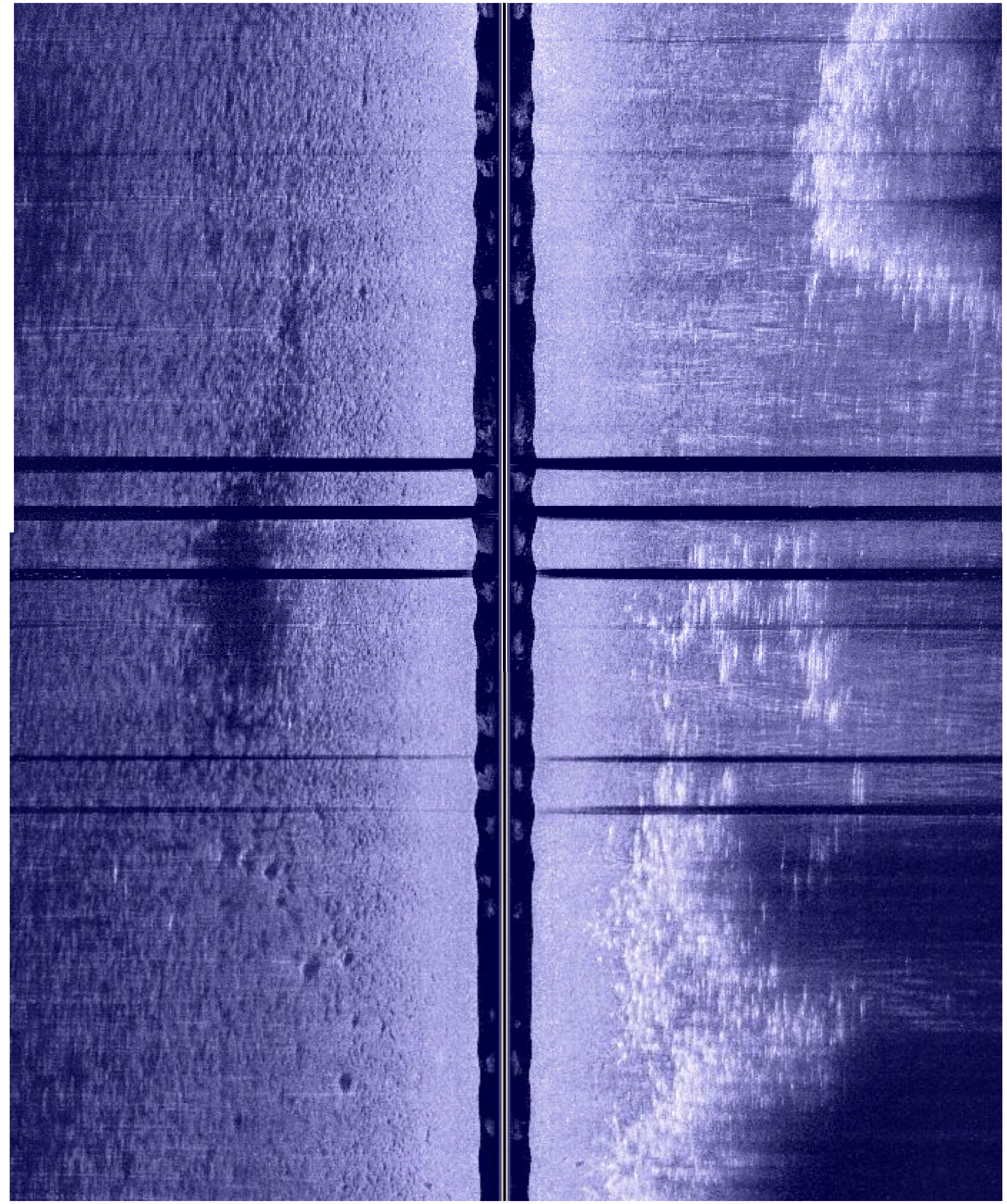
Weather/Surface Conditions

Wave action

What happens when the wind starts to build waves across the surface of the river or lake, or a passing boat throws a large wake? The front of the survey boat starts to bob up and down, and the transducer may be lifted out of the water. This is exactly what is happening in the image shown here. A moderate chop on this lake was occasionally lifting the front end of the boat high enough that the transducer came out of the water (the black lines). Upon close inspection of the water column, even the bottom appears to be undulating or wavy. This effect is artificial, and is being caused by the pitch of the bow.

The best imaging will likely occur during flat, calm surface conditions. If working in broad rivers, or any open water situation, the effect of wind and wave action must be considered when planning and executing sonar surveys. Excessively windy and choppy conditions can severely hinder both imaging and navigation.

*The bright sonar signatures on the right hand side of this image represent beds of aquatic vegetation.



Best to avoid

Traffic on the water can come in many forms: anchored boats, jet skiers, kayakers, bass fisherman, swimmers, sunbathers, deadhead loggers, you name it! When you are in the middle of a long, uninterrupted survey transect, the last thing you want to do is detour around traffic or have to stop altogether. Let's discuss the example shown here. Our objective was to conduct a shoreline habitat survey in a reservoir cove. We determined that 85 feet per side range would allow us to generate high resolution data while passing directly in front of dozens of docks and piers (actual boat path in blue). When do you think we conducted this survey? February- when noone was out on the docks fishing or enjoying a brew.

This concludes Session II- Part A on Mission Planning. Next we will discuss the field execution of the sonar mission.

Traffic