NAUTICOS

"Search for Amelia Earhart"

Education & Public Outreach
Expedition 2017 Module

February 19, 2017

Fellow Explorers:

It is my great pleasure to invite you to be remote explorer participants in the Nauticos - Eustace Team's "Search for Amelia Earhart" expedition.

As you'll learn from the activities in this Pre-Mission Module, Amelia Earhart's disappearance during her last flight while trying to be the first woman to fly around the world is one of the greatest aviation mysteries of the twentieth century.

Although there are numerous theories as to what might have happened to Amelia and her navigator Fred Noonan NONE have ever been proven. We must find Amelia's Electra 10 E plane to solve the mystery.

The Nauticos team has gathered all available information about Amelia's last flight and analyzed the information carefully to select a probable search area in the Pacific Ocean.

A special Nauticos "Remote Participant Expedition Portal" has been created for educational audiences to participate in the expedition search. The activities in this module and information posted on the portal will prepare you for remote participation with the expedition team.

Participating in the module activities you will learn the facts about Amelia's last flight up until the time she disappeared and determine where you would search. You will learn how the Woods Hole's Oceanographic Institution's REMUS, Autonomous Underwater Vehicle carrying a side scan sonar payload and cameras makes it possible for the expedition team to map objects on the deep sea floor. You will learn from Nauticos experts how to analyze sonar data and what the team will be looking for to confirm a target as Amelia's Electra 10 E airplane.

Remember to send your questions to the Nauticos Expedition Team and keep checking the portal for mission updates.

Welcome Aboard!

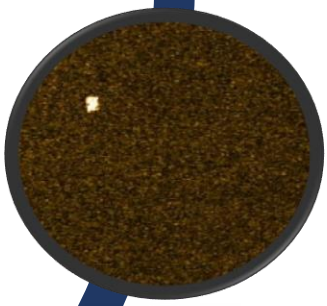
Dave Jourdan,

Dave Jourdan, Expedition Leader
Nauticos,, LTD

Solving the Mystery

Q. **What happened to Amelia Earhart, Fred Noonan & the Electra 10 E?**

TABLE OF CONTENTS



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Education Module Lesson Videos

Dave Jourdan, Nauticos
Expedition Leader

Amelia's Last Flight

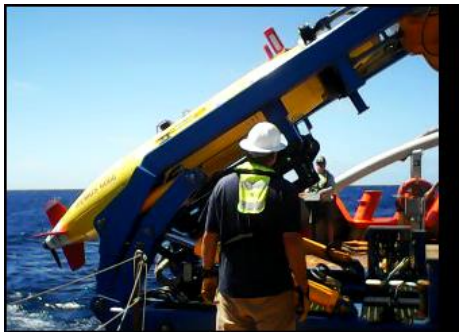
Elgen Long, Author
Nauticos Search Advisor

Rod Blocksome,
Rockwell Collins
Last Flight Radio Analysis

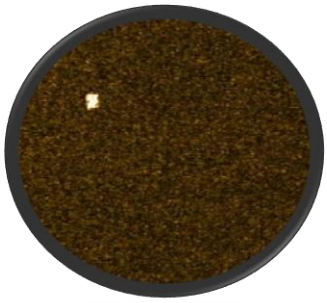
Tom Dettweiler, Nauticos
Expedition Survey Manager

REMUS 6000
AUV

Greg Packard,
Woods Hole
Oceanographic
Institution



REMUS Launch



Side Scan Sonar Target Data Analysis

Tom Dettweiler, Nauticos

Jeff Morris, Nauticos

Amelia's Customized Electra 10E

Jon Thompson, Nauticos
Exhibit Manager

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The real-world Eustace Earhart "Search for Amelia" STEM mission <u>strongly</u> aligns with the following Next Generations <u>Applied</u> Science Standards.

Practices

- ☐ Asking questions and defining problems.
- ☐ Planning and carrying out investigations.
- ☐ Analyzing and interpretting data
- ☐ Constructing explanations
- ☐ Engaging in argument from evidence.

Cross-Cutting Concepts

- ☐ Cause and effect
- ☐ Influence of engineering,
- ☐ Influence of technology on society & natural world
- ☐ Structure and function

Name: _____ **Date:** _____

Amelia Earhart's Last Flight from Lae to Howland Island

Electra take-off from Lae, New Guinea

On July 2, 1937 Amelia Earhart and her navigator Fred Noonan took off in her customized Lockheed Electra 10 E plane from the Lae airport in New Guinea heading for Howland Island in the Pacific Ocean where she would refuel and continue her journey to be the first pilot to circumnavigate the world at the equator.

While radio operators at Lae airport and on the Coast Guard ship *Itasca* near Howland Island heard and recorded messages from Amelia along her flight route Amelia never made it to Howland Island and was never heard from again after transmitting her last message at 2013 Greenwich Civil Time (GCT).

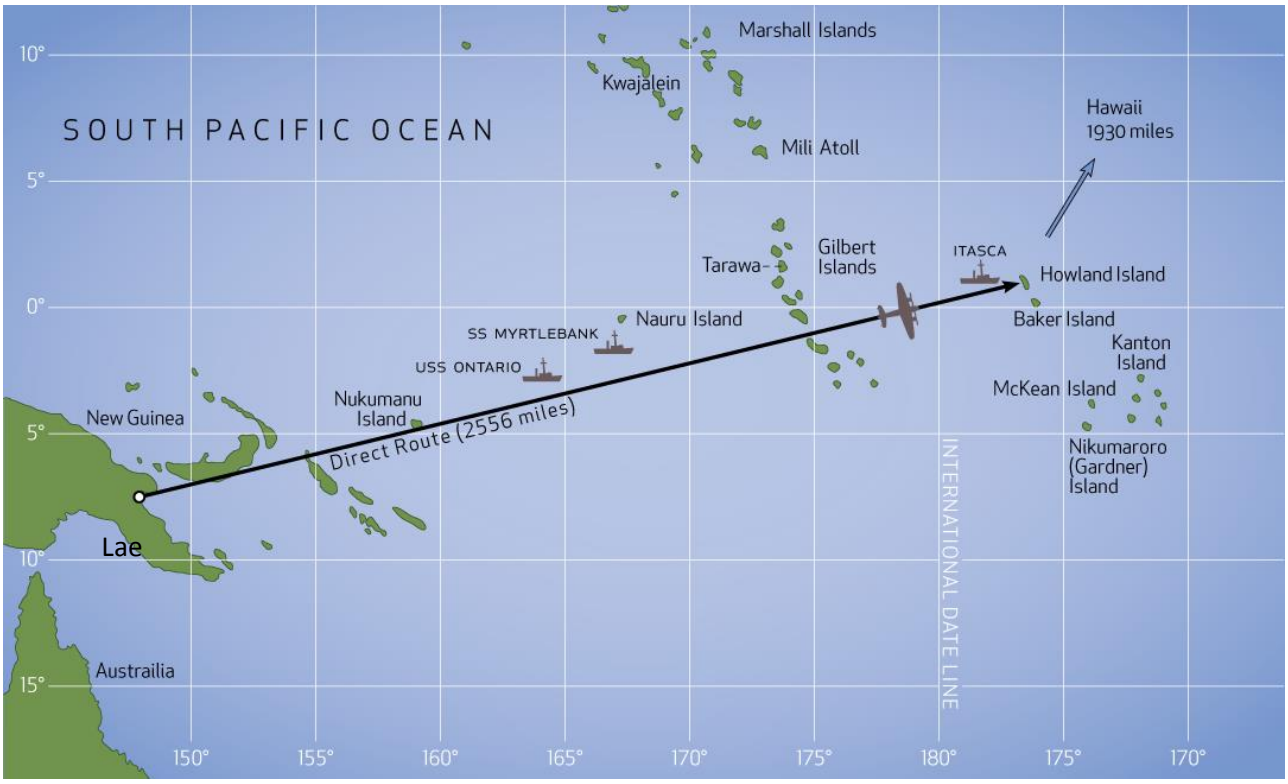
Many searches were conducted but no trace of Amelia, Fred or the plane were ever found. There are many theories about what might have happened to Amelia, none have been proven. It is one of the greatest mysteries of the twentieth century.

The Nauticos Eustace Earhart Expedition Team have gathered and studied information about Amelia's last flight including radio messages, signal strength, weather, fuel, Noonan navigation techniques and invite remote student/teacher explorers to join us in solving the mystery of what happened to Amelia Earhart and Fred Noonan during their last flight to Howland Island.

Name: _____ **Date:** _____

Amelia Earhart's Direct Flight Plan Leaving Lae New Guinea Heading to Howland Island for Refueling

Directions: Read the Radio Messages transmitted by Amelia during her last flight and plot the flying position she provided at the time of the message by placing a circle on the Direct Route Flight Path from Lae Airport to Howland Island. Please also write the time of the message not on the line but somewhere near the dot and if provided, the radio message signal strength.



The flight path, radio messages stating position, documented time, weather condition reports and fuel consumption status all provide important information about Amelia's last flight and how close she was to Howland Island before she vanished. This information as well as having knowledge of the navigation techniques used at the time of Amelia's flight all helped the Nauticos Eustace Earhart Expedition Search Team define a search area to look for Amelia's lost Electra and finally solve the mystery of what happened to Amelia and Fred during their last flight.

Based on the radio messages with the last one stating that Amelia and Fred couldn't see Howland Island but would be flying a line north and south to hopefully see it before they ran out of gas where do you think the Nauticos team should search for Amelia's Electra plane? Please draw a geometric shape around the area you would search for Amelia's Electra on the map.

Documented Last Flight
Radio Messages Heard From the Electra

Amelia on radio in the Electra

Q. ***What happened to Amelia Earhart, Fred Noonan and the Electra 10 E during Amelia's flight from Lae, New Guinea to Howland Island?***

During Amelia's flight from Lae to Howland Island she sent a confirmed radio message to the Commander of the Coast Guard ship, *Itasca* positioned two miles off Howland Island that she would broadcast messages using **G**reenwich **C**ivil **T**ime during her flight as she would travel though different time zones. The messages below list Amelia's GCT time for messages sent and the local time and locations the messages were received by: Lau airport, Nauru Island, Coast Guard ship *Itasca* and Howland Island radio station operators.

Greenwich Civil Time (GCT) Time Amelia or Fred sent a radio message from the Electra	Listening Radio Station Location and Time	Documented Messages Heard From the Electra	NOTES
0000 GCT From Fred Noonan	10:00 a.m. LAE Airport Radio Station	**"Lift-Off Time 0000 GCT"**	**Fact 1:** Fred Noonan reported the Electra lift-off time as 0000 GCT which was 10:00a.m. Lae New Guinea time. **Note:** Time is valuable in calculating Amelia's flight time and speed.
0418 GCT From Amelia Earhart	2:18 p.m. LAE Airport Radio Station	**"Height: 7,000 ft. Speed: 140 knots, Lae everything okay"**	**Fact 2:** At 0418 GTC (2:18 p.m.) Harry Balfour, the New Guinea Airways radio operator at Lae reported that he had received a radio transmission from Amelia. She reported: "Height (meaning altitude): 7,000 Feet, Speed 140 knots, Lae and everything okay."
0519 GCT From Amelia Earhart	3:19 p.m. LAE Airport Radio Station	**"Height: 10,000ft. Position: 150.7° East, 7.3° South, Cumulus Clouds, Everything Okay."**	**Fact 3:** At 0519 GTC Harry received another radio transmission report from Amelia. She reported: "Height (meaning altitude) 10,000 Feet, Position: 150.7° East, 7.3° South, Cumulus Clouds, Everything okay."
0718 GCT From Amelia Earhart	5:18 p.m. LAE Airport Radio Station	**"Position: 4.33° South, 159.7° East, Height: 8,000f ft. over cumulus clouds, Winds 23 knots."**	**Fact 4:** At 0718 GCT Balfour clearly heard Amelia's next transmission. She said: "Position – 4.33° South, 159.7° East Height 8,000 ft. over cumulus clouds, Wind 23 knots."

			Notes: Amelia's precise position at 5:18 p.m. is known making it possible to calculate her ground speed from Lae to this position. The Electra was now 850 miles from Lae and exactly on course for Howland Island. **Weather:** Amelia and Fred were flying into direct headwinds as reported by Amelia as 23 knots. The stronger the headwinds the faster a plane must fly. Calculations indicate that Amelia would now burn 9% of her fuel per hour. This meant the Electra would arrive at Howland Island very low on fuel.
1030 GCT **From Amelia Earhart**	10:30 GCT Nauru Island Radio Station Note the change in the station receiving the message from Amelia and the change in time. This is because of changing time zones.	**"A ship in sight ahead."**	**Fact 5:** At 1030 GCT Amelia transmitted a radio report that said: "A ship in sight ahead." **Notes:** Knowing Amelia's position at 5:18 p.m. and speed, if continued, she would have passed the ship *Ontario* an hour earlier and by calculation should be approaching Nauru. The SS Myrtlebank was positioned 80 miles south of Nauru Island. Harold J. Barnes, in charge of the radio station recorded Amelia's "A ship in sight ahead" message.
1415 GCT **From Amelia Earhart**	2:45 a.m. Itasca Ship Radio Station Note: The Coast Guard Ship, *Itasca* was stationed 2 miles off Howland Island in waiting to	**"Cloudy and overcast"**	**Fact 6:** At 1415 GCT *Itasca* Ship Radio Operator recorded a message from Amelia writing: Lots of static. "Cloudy and Overcast"

	receive messages from the Electra. The time has changed again to *"Itasca ship time".*		
1515 GCT From Amelia Earhart	3:45 a.m. *Itasca* Ship Time	**"*Itasca* From Earhart – *Itasca* From Earhart – overcast – will listen on hour and half hour on 3105 – will listen on hour and half hour on 3105."**	**Fact 7:** At 1515 GCT Amelia transmitted the following message heard and recorded by an *Itasca* ship radio operator at position 2. "Itasca From Earhart – Itasca From Earhart – overcast – will listen on hour and half hour on 3105 – will listen on hour and half hour on 3105."
1623 GCT From Amelia Earhart	4:53 a.m. *Itasca* Ship Time	**"Partly cloudy"**	**Fact 8:** At 1623 GCT Amelia transmitted another report to the *Itasca* and the radio operator reported hearing Amelia say "partly cloudy".
1744 GCT From Amelia Earhart	6:14 a.m. Itasca Ship Time	**"Want bearing on 3105 Kcs – on hour- will whistle in mic."**	**Fact 9:** At 1744, the Itasca transcribed Amelia's message – "Want bearing on 3105kcs - on hour - will whistle in mic." **Notes:** Amelia was going to whistle into her radio microphone so the *Itasca* ship could locate her position. 3105 was Amelia's radio voice frequency. "Kcs" means kilocycles and means the number of frequency waves per second.
1745 GCT From Amelia Earhart	6:15 a.m. *Itasca* Ship Time	**"About 200 miles out – approximately – whistling now."**	**Fact 10:** 1745 GCT Amelia sent this message that *Itasca* recorded: "About 200 miles out//AppX/ Whistling/ / NW" **Notes:** The *Itasca* radio operator noted Amelia's message received with a signal strength (ability to hear

			the message clearly) as a **Signal Strength – S 3.** The Howland Island *Itasca* personnel were unable to take a bearing position on Amelia's whistling in the mic as the Direction Finder battery on Howland Island was dead.
1815 GCT **From Amelia Earhart**	6:45 a.m. *Itasca* Ship Time	**"Please take bearing on us and report in half hour. I will make noise in microphone – About 100 miles out."**	**Fact 11: 1815 GCT Amelia transmitted the following message to Itasca:** "Please take bearing on us and report in half hour. I will make noise in microphone – About 100 miles out." **Notes:** The *Itasca* Position 2 radio operator noted **the signal strength of this message from Amelia as S4.** Note the signal strength, clarity of Amelia's messages are increasing the closer she gets to the *Itasca* and Howland Island. *Itasca,* Chief radio operator Bellarts sent a message to Amelia indicating they could not take a bearing on 3105. No response was heard from Amelia. With one generator on board it was unlikely her radio would be on except during scheduled message times.
1912 GCT **From Amelia Earhart**	7:42 a.m. *Itasca* Ship Time	**"KHAQQ calling *Itasca*. We must be on you but cannot see you. But gas is running low. Been unable to reach you by radio. We are flying at 1,000ft "**	**Fact 12:** At 1912 GCT Amelia transmitted a message for Itasca: "KHAQQ calling *Itasca.* We Must be on you but cannot see you. But gas is running low. Been unable to reach you by radio. We are flying at altitude 1,000 ft."

			Note: The Itasca Radio operator at position 2 recorded **Amelia's message as a S-5 in signal strength,** (loud and clear)
1928 GCT **From Amelia Earhart**	7:58 a.m. *Itasca* Ship Time	**"KHAQQ calling *Itasca* – we are circling but cannot hear you. Go ahead on 7500 with a long count either now or on the scheduled time on half hour"**	**Fact 13: At 1928 GCT** Amelia transmitted a message for *Itasca* "KHAQQ calling *Itasca* – <u>we are circling</u> but cannot hear you. Go ahead on 7500 with a long count either now or on the scheduled time on half hour." **This message was rated with a signal strength of S-5+** **Notes:** **"KHAQQ"** was Amelia's radio ID. **"Long Count"** – Amelia was requesting the *Itasca* radio operators to tune to frequency 7500 and provide a slow count "**1, 2, 3, 4, 5, 6, 7. 8. 9. 10, 9. 8. 7. 6. 5. 4. 3. 2. 1"** so she and Fred her navigator could get a bearing (locate) the *Itasca***.** **In a post search report sent to San Francisco, Commander Thompson of the *Itasca* wrote based on signal strength 5+ he believed Amelia was closest to the *Itasca* during Amelia's 7:58 message.**
1930 GCT **From Amelia Earhart**	8:03 a.m. *Itasca* Ship Log Recorded Time	**"KHAQQ calling *Itasca.* We received your signals but unable to get a minimum. Please take bearing on us and answer 3105 with voice." Amelia the sent three long dashes to**	**Fact 14: At 1930 GCT Amelia said:** **"KHAQQ calling *Itasca* we received your signals but unable to get a minimum. Please take bearing on us and**

		Itasca **to get a bearing on them.**	**answer 3105 with voice." Amelia then made 3 long dashes for *Itasca* to get a bearing on them.** **Notes:** At 8:04 a.m. Howland Island Radio Operators sent a message to *Itasca* that it was impossible as the Direction Finder batteries on Howland were dead
2013 GCT **From Amelia Earhart**	8:43 a.m. *Itasca* Ship Time	**"KHAQQ to Itasca. <u>We are on the line of position 157 – 337</u>, will repeat this message** **Will repeat this message on 6210 KCS. Wait listening on 6210 KCS. <u>We are running on North and South</u>."**	**Fact 15:** At 2013 GCT Amelia Transmitted the following message "We are on the line of position 157 – 337, will repeat this message Will repeat this message on 6210 KCS. Wait listening on 6210 KCS. We are running North and South." **Notes:** *Itasca* radio operators assigned voice **signal strength S 5 for this message.** *Itasca* constantly sent unanswered messages to Amelia on radio frequency 7500 and created smoke which unfortunately spread out ship level instead of going high in the air. Right after this message Amelia's Electra engines should have been out of gas. Amelia would have to keep the Electra's nose up and go for a controlled landing in the Pacific Ocean somewhere near Howland Island.

Q. What technology is needed to search for Amelia Earhart's Electra?

REMUS 6000 - AUV

For Deep Ocean, Large Area Search Surveys

Remote Environmental Monitoring UnitS

REMUS is the perfect remote sensing technology platform to help the Nauticos Team locate target "Electra" thought by this team to be resting deep in the Pacific Ocean. The team from Woods Hole Oceanographic Institution engineers and operates the REMUS AUV.

REMUS is an autonomous underwater vehicle, or AUV, which is capable of bringing high resolution imaging sensors down close to the seafloor. The vehicle can operate in the deep ocean able to swim to water depths of 6000 meters. The REMUS AUV is not connected to the surface with a cable which makes it efficient in carrying out its survey and mapping work but does mean it must be equipped with large batteries for power and a computer 'brain' to control its movements over the bottom.

REMUS has a side scan sonar which will be the primary tool utilized to search for Amelia Earhart's Electra. The side scan sonar utilizes projected acoustical pulses, or 'pings', to produce a map of the ocean floor and detect objects. The sonar does this by measuring the intensity of the 'echoes' returned back to the sonar from each 'ping'. The intensity, or brightness, of the returning echoes allows objects and geological features to stand out against the ocean bottom. REMUS is also equipped with a high resolution camera and strobe light which can take pictures of objects on the sea floor.

<u>Directions</u>: Please watch the Woods Hole Team's REMUS 6000 introductory video and operations animation. Be ready to explain why the REMUS 6000 is a good tool to use for the Nauticos search for Amelia's Electra. A Nauticos expedition REMUS launch video has been provided for your enjoyment on its way to search the seafloor for Amelia's Electra.

REMUS Operation Animation

https://www.whoi.edu/page.do?pid=38144&cid=120513&tid=7842

Tom Dettweiler, Nauticos

Nauticos Eustace Earhart Discovery Expedition
Learning to Analyze Side Scan Sonar Data
Lesson Activity

Jeff Morris. Nauticos

Q. How can viewers distinguish sonar data of Amelia Earhart's Electra from natural geologic ocean features?

LESSON OVERVIEW - In this lesson, Nauticos sonar experts explain how side scan sonar works and teach remote expedition explorers how to distinguish sunken man-made sonar targets from natural geologic ocean features and the ocean bottom. Students will also be challenged by the Nauticos Sonar Team to identify features from four real-world side scan sonar images using the six criteria method of analysis shown in the video.

Materials: (Teacher)

- (1) Teacher Introduction Side Scan Sonar Image
- Computer & Projector to display the Side Scan Sonar Image
- Tom Dettweiler & Jeff Morris Video

Materials: (per group of 4 students)

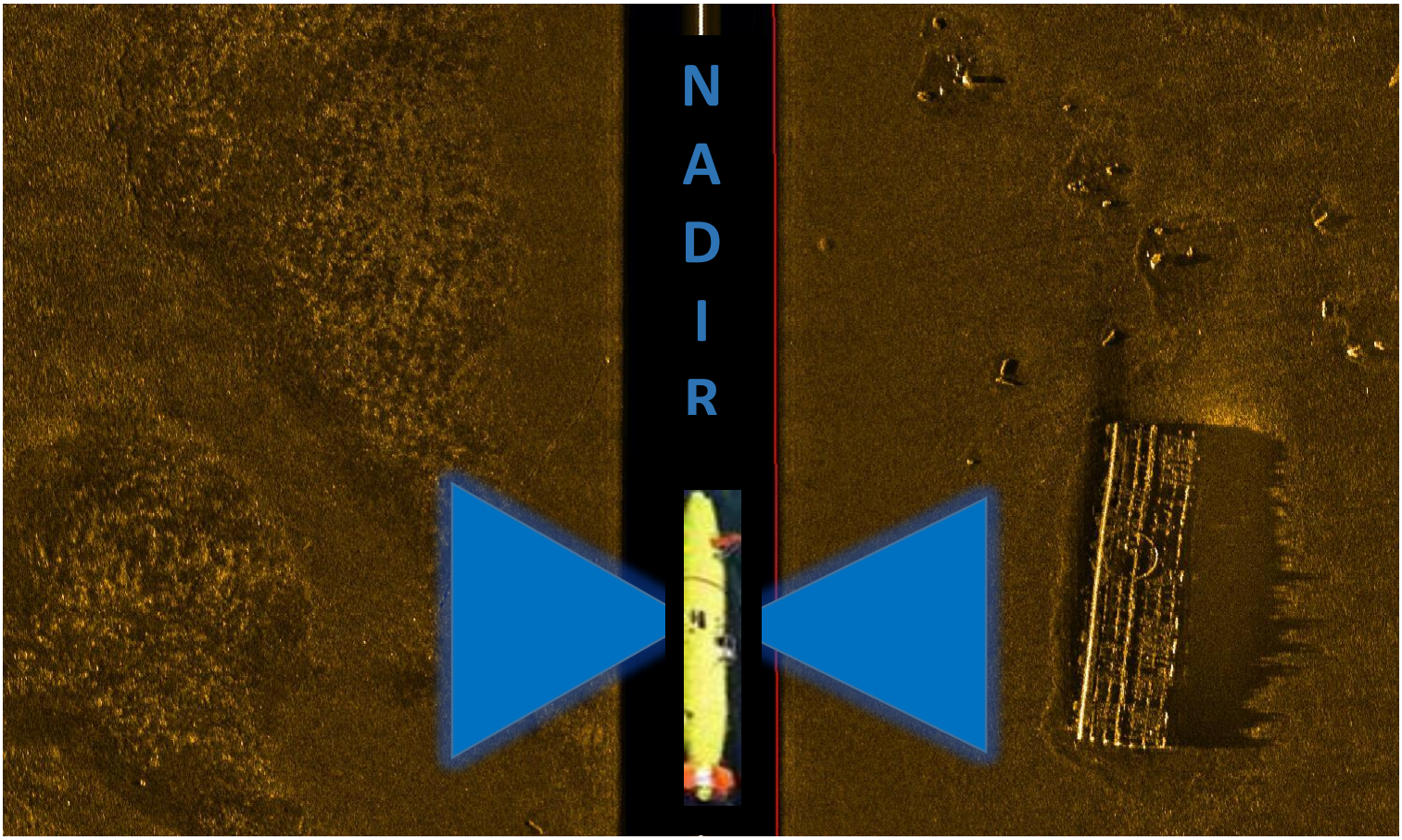
- One Side Scan Sonar Image
- 5-Step Sonar Analysis Criteria Information (displayed or hand-out to students)
- Pencil

5 E's Lesson Plan

ENGAGE	The instructor will display the Teacher Introduction Sonar Image to the remote expedition student explorers with instruction to make and discuss observations with teammates. Let the students know that "Nadir" is the water column beneath Remus that is not scanned by sonar. The student teams will then be invited to share their observations in a whole group discussion.
EXPLORE	The instructor will then invite students to watch a short side scan sonar introduction and analysis video of Nauticos experts with the Focus for Viewing assignment for students to be ready to share why sonar is better for initial target search than cameras and to identify at least one of the six criteria used for distinguishing man-made objects from ocean features. The teacher will then direct student attention back to the original sonar image and guide students to identify features using the six criteria technique shared by Jeff in the video using a sonar image key provided. Student explorer teams will then be given one of four sonar images to analyze using the six criteria analysis technique.
EXPLAIN	The teacher will display each of the four images and call on student explorer teams to share analysis results using the six criteria sonar analysis technique. A teacher Side Scan Sonar Teacher Guide has been provided for each sonar image.

ELABORATE	Student expedition explorers will be invited to continue to analyze Nauticos Expedition Sonar Images posted daily on the Nauticos Expedition Portal and to send any questions they have to the Nauticos Expedition Sonar Team.
EVALUATE	Evaluation should be on-going throughout the lesson with the instructor monitoring student responses to questions, ability to identify six criteria analysis technique for analysis of sonar imagery and correct identification of features in sonar images.

Q. What do you observe looking at the sonar image?



Side Scan Sonar Acoustic Data Image – 50m Range

<u>After Video Directions – Whole Class – Teacher Led</u>: Take a second look at the sonar image and check off any of the criteria listed in the table below observed in the sonar image. Be ready to share your team's observations with the class.

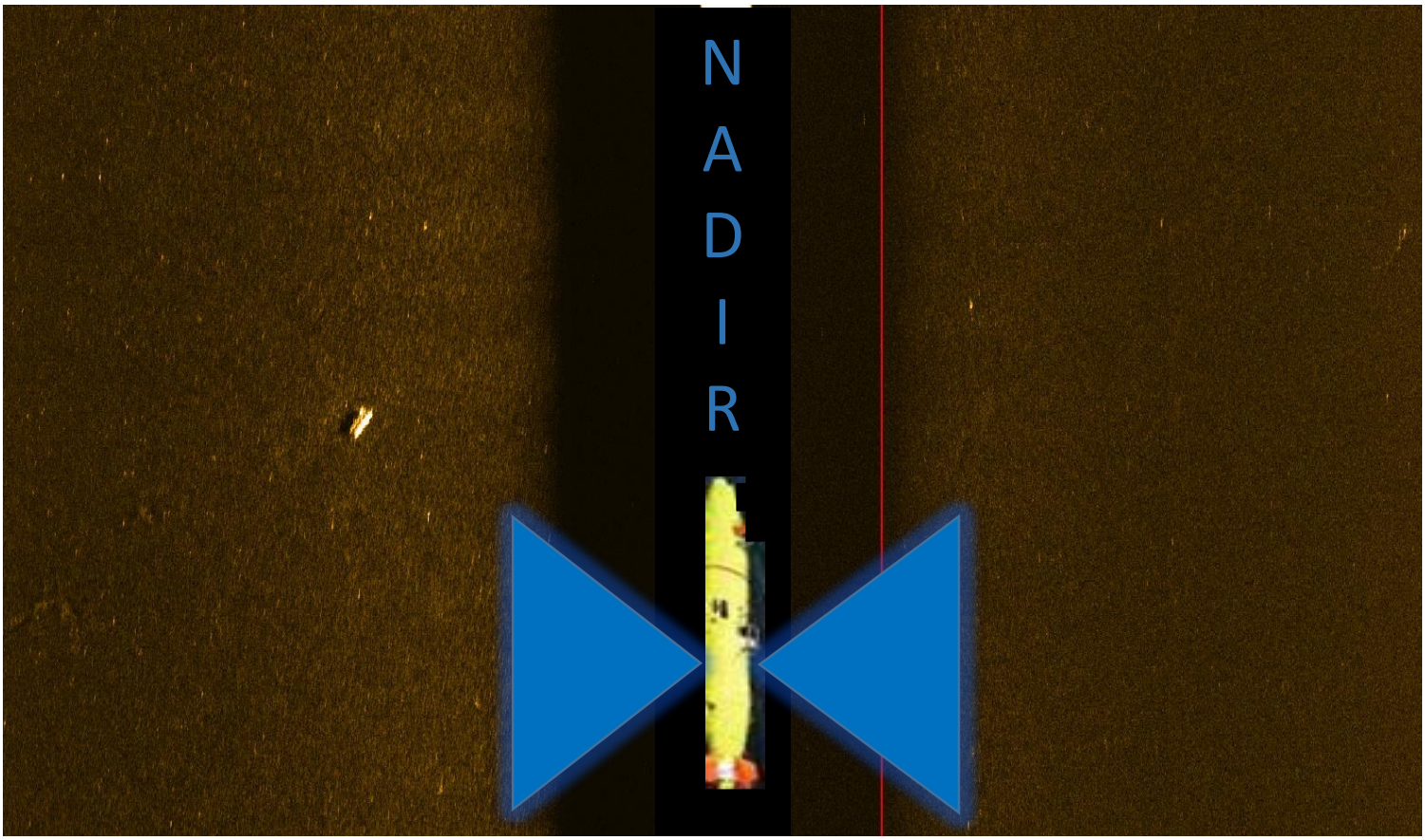
6 – Step Sonar Analysis Criteria for Identifying Man-Made Targets

	☑
1. The target's acoustic **reflectivity** is much **brighter** than the surrounding area.	☐
2. The **size** of the target is about the **right size** for the object.	☐
3. The target **casts a shadow** indicating height above the sea floor.	☐
4. The target is **not** associated or part of the surrounding geology.	☐
5. The target has a **geometric** shape.	☐
6. A **debris field** with multiple objects over a small area might be near the target.	☐

Name(s) _____ Date: _____

Student Teams Side Scan Sonar Image # 1

Q. What do you observe looking at the sonar image?



Side Scan Sonar Acoustic Data Image 20m Range

Directions: Check off any of the man-made object criteria listed in the table below observed in the sonar image. Then, share your observations with your group and be ready to present as a team the observation analysis for your assigned sonar image with the rest of the class.

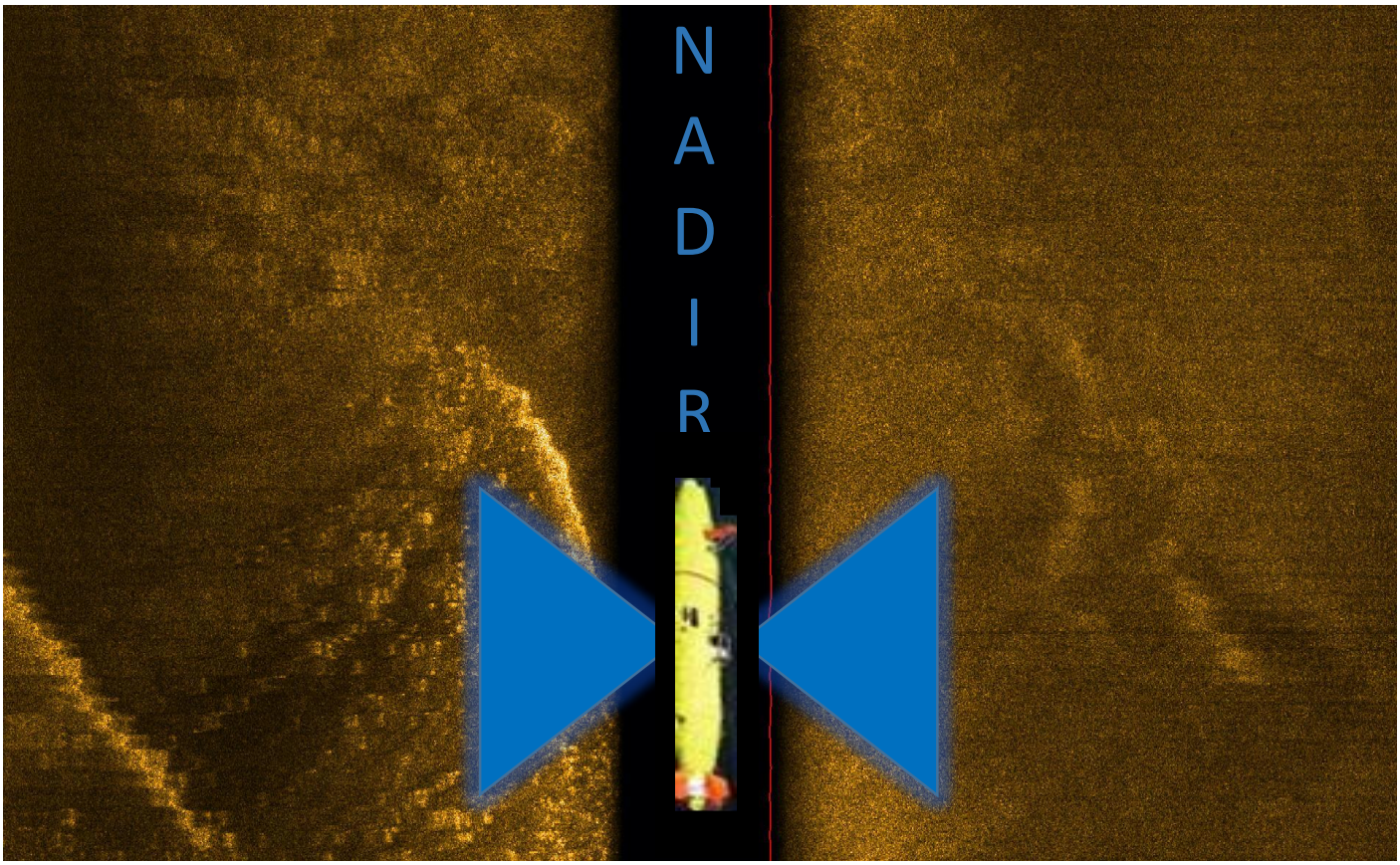
6 – Step Sonar Analysis Criteria for Identifying Man-Made Targets

	☑
1. The target's acoustic **reflectivity** is much **brighter** than the surrounding area.	☐
2. The **size** of the target is about the **right size** for the object.	☐
3. The target **casts a shadow** indicating height above the sea floor.	☐
4. The target is **not** associated or part of the surrounding geology.	☐
5. The target has a **geometric** shape.	☐
6. A **debris field** with multiple objects over a small area might be near the target.	☐

Name(s) _____ Date: _____

Student Teams Side Scan Sonar Image # 2

Q. What do you observe looking at the sonar image?



Side Scan Sonar Acoustic Data Image 50m Range

Directions: Check off any of the man-made object criteria listed in the table below observed in the sonar image. Then, share your observations with your group and be ready to present as a team the observation analysis for your assigned sonar image with the rest of the class.

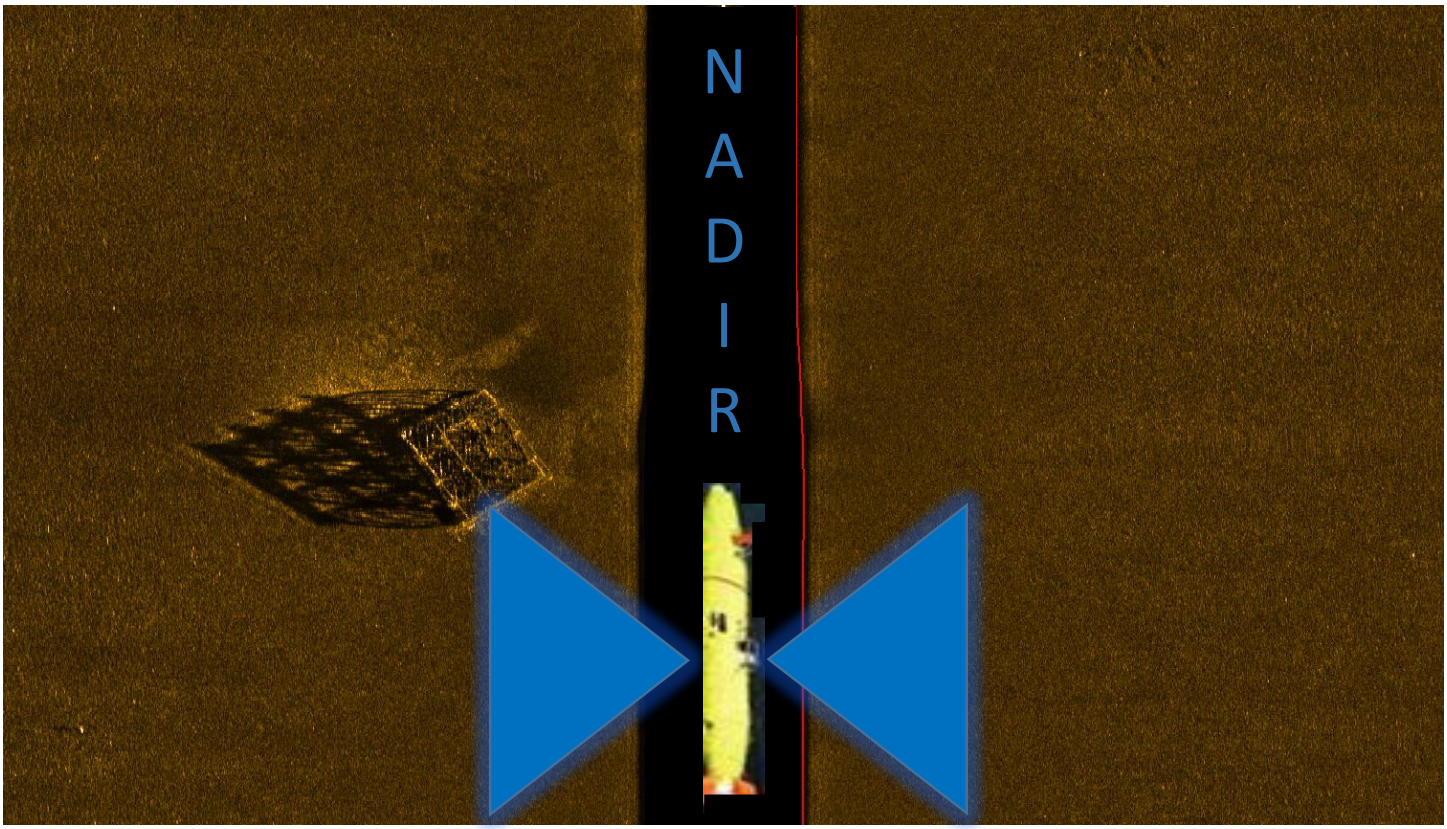
6 – Step Sonar Analysis Criteria for Identifying Man-Made Targets

	☑
1. The target's acoustic **reflectivity** is much **brighter** than the surrounding area.	☐
2. The **size** of the target is about the **right size** for the object.	☐
3. The target **casts a shadow** indicating height above the sea floor.	☐
4. The target is **not** associated or part of the surrounding geology.	☐
5. The target has a **geometric** shape.	☐
6. A **debris field** with multiple objects over a small area might be near the target.	☐

Name(s) _____ Date: _____

Student Teams Side Scan Sonar Image # 3

Q. What do you observe looking at the sonar image?



Side Scan Sonar Acoustic Data Image 50m Range

Directions: Check off any of the man-made object criteria listed in the table below observed in the sonar image. Then, share your observations with your group and be ready to present as a team the observation analysis for your assigned sonar image with the rest of the class.

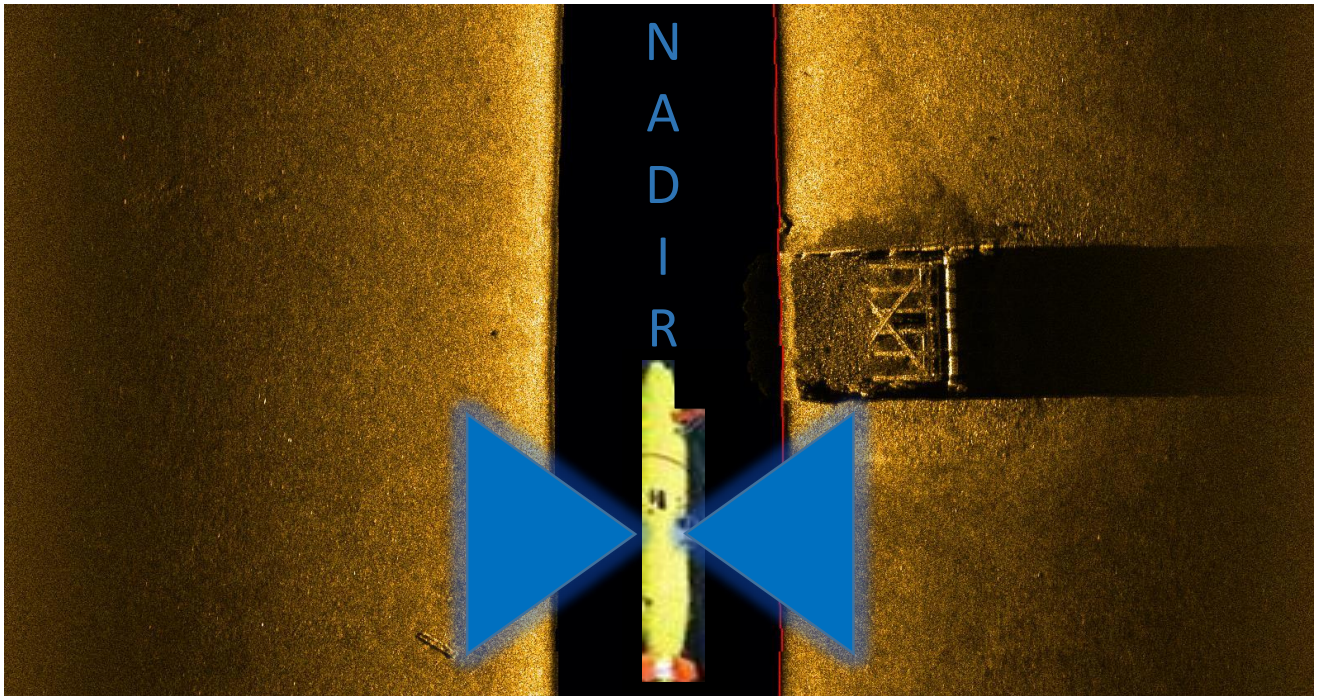
6 – Step Sonar Analysis Criteria for Identifying Man-Made Targets

	☑
1. The target's acoustic **reflectivity** is much **brighter** than the surrounding area.	☐
2. The **size** of the target is about the **right size** for the object.	☐
3. The target **casts a shadow** indicating height above the sea floor.	☐
4. The target is **not** associated or part of the surrounding geology.	☐
5. The target has a **geometric** shape.	☐
6. A **debris field** with multiple objects over a small area might be near the target.	☐

Name(s) _____ Date: _____

Student Teams Side Scan Sonar Image # 4

Q. What do you observe looking at the sonar image?



Side Scan Sonar Acoustic Data Image 25m Range

Directions: Check off any of the man-made object criteria listed in the table below observed in the sonar image. Then, share your observations with your group and be ready to present as a team the observation analysis for your assigned sonar image with the rest of the class.

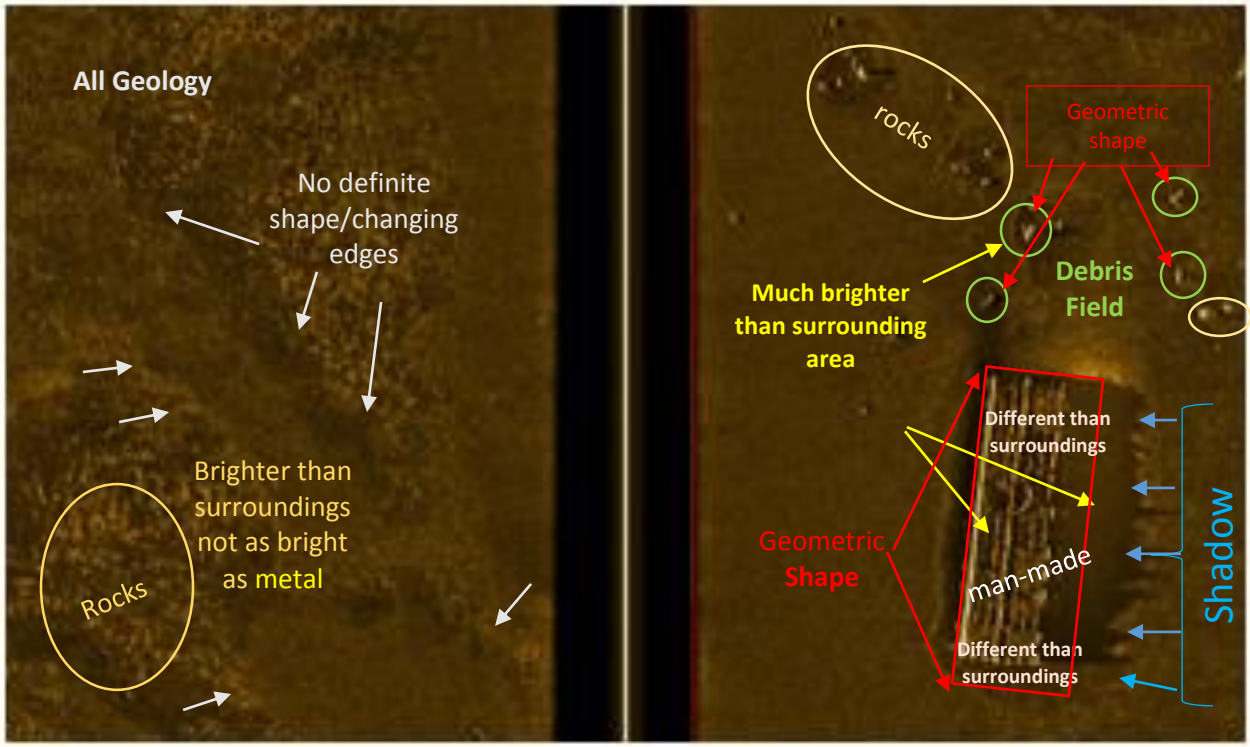
6 – Step Sonar Analysis Criteria for Identifying Man-Made Targets

	☑
1. The target's acoustic **reflectivity** is much **brighter** than the surrounding area.	☐
2. The **size** of the target is about the **right size** for the object.	☐
3. The target **casts a shadow** indicating height above the sea floor.	☐
4. The target is **not** associated or part of the surrounding geology.	☐
5. The target has a **geometric** shape.	☐
6. A **debris field** with multiple objects over a small area might be near the target.	☐

TEACHER GUIDE TO LEAD THE WHOLE CLASS STUDENT OBSERVATION DISCUSSION

Teacher Introduction Side Scan Sonar Image
For Whole Class Analysis

Q. What do you observe looking at the sonar image?



Side Scan Sonar Acoustic Data Image 50m Range

<u>After Video Directions – Whole Class – Teacher Led</u>: Take a second look at the sonar image and check off any of the criteria listed in the table below observed in the sonar image. Be ready to share your team's observations with the class.

6 – Step Sonar Analysis Criteria for Identifying Man-Made Targets

	☑
1. The target's acoustic **reflectivity** is much **brighter** than the surrounding area.	✓
2. The **size** of the target is about the **right size** for the object.	☐
3. The target **casts a shadow** indicating height above the sea floor.	✓
4. The target is **not** associated or part of the surrounding geology.	✓
5. The target has a **geometric** shape.	✓
6. A **debris field** with multiple objects over a small area might be near the target.	✓

Teacher Analysis Guide for Student Side Scan Sonar Image # 1

Name(s) _____ Date: _____

Student Teams Side Scan Sonar Image # 1

Q. What do you observe looking at the sonar image?

Side Scan Acoustic Data Image 20m Range

Directions: Check off any of the man-made object criteria listed in the table below observed in the sonar image. Then, share your observations with your group and be ready to present as a team the observation analysis for your assigned sonar image with the rest of the class.

6 – Step Sonar Analysis Criteria for Identifying Man-Made Targets

	☑
1. The target's acoustic **reflectivity** is much **brighter** than the surrounding area.	✓
2. The **size** of the target is about the **right size** for the object.	☐
3. The target **casts a shadow** indicating height above the sea floor.	✓
4. The target is **not** associated or part of the surrounding geology.	✓
5. The target has a **geometric** shape.	✓
6. A **debris field** with multiple objects over a small area might be near the target.	☐

Teacher Analysis Guide for Student Side Scan Sonar Image # 2

Name(s) _____ Date: _____

Student Teams Side Scan Sonar Image # 2

Q. What do you observe looking at the sonar image?

Side Scan Sonar Acoustic Data Image 50m Range

Directions: Check off any of the man-made object criteria listed in the table below observed in the sonar image. Then, share your observations with your group and be ready to present as a team the observation analysis for your assigned sonar image with the rest of the class.

6 – Step Sonar Analysis Criteria for Identifying Man-Made Targets

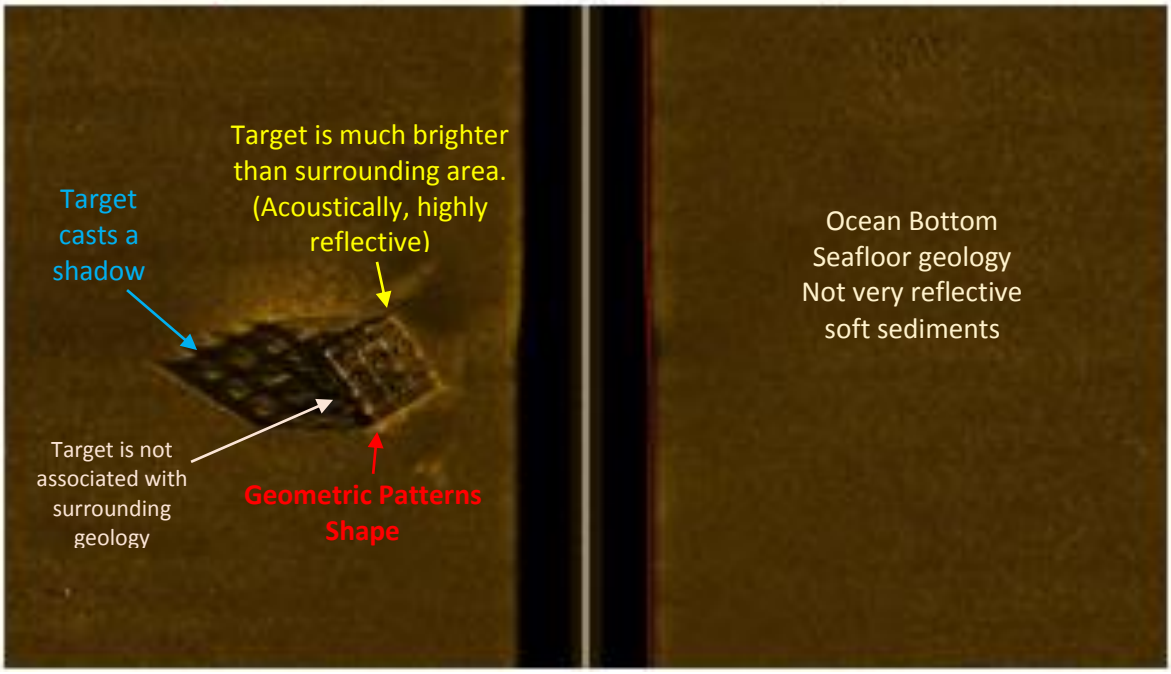
	☑
1. The target's acoustic **reflectivity** is much **brighter** than the surrounding area.	☐
2. The **size** of the target is about the **right size** for the object.	☐
3. The target **casts a shadow** indicating height above the sea floor.	☐
4. The target is **not** associated or part of the surrounding geology.	☐
5. The target has a **geometric** shape.	☐
6. A **debris field** with multiple objects over a small area might be near the target.	☐

Teacher Analysis Guide for Student Side Scan Sonar Image # 3

Name(s) _____ Date: _____

Student Teams Side Scan Sonar Image # 3

Q. What do you observe looking at the sonar image?



Side Scan Acoustic Data Image 50m Range

Directions: Check off any of the man-made object criteria listed in the table below observed in the sonar image. Then, share your observations with your group and be ready to present as a team the observation analysis for your assigned sonar image with the rest of the class.

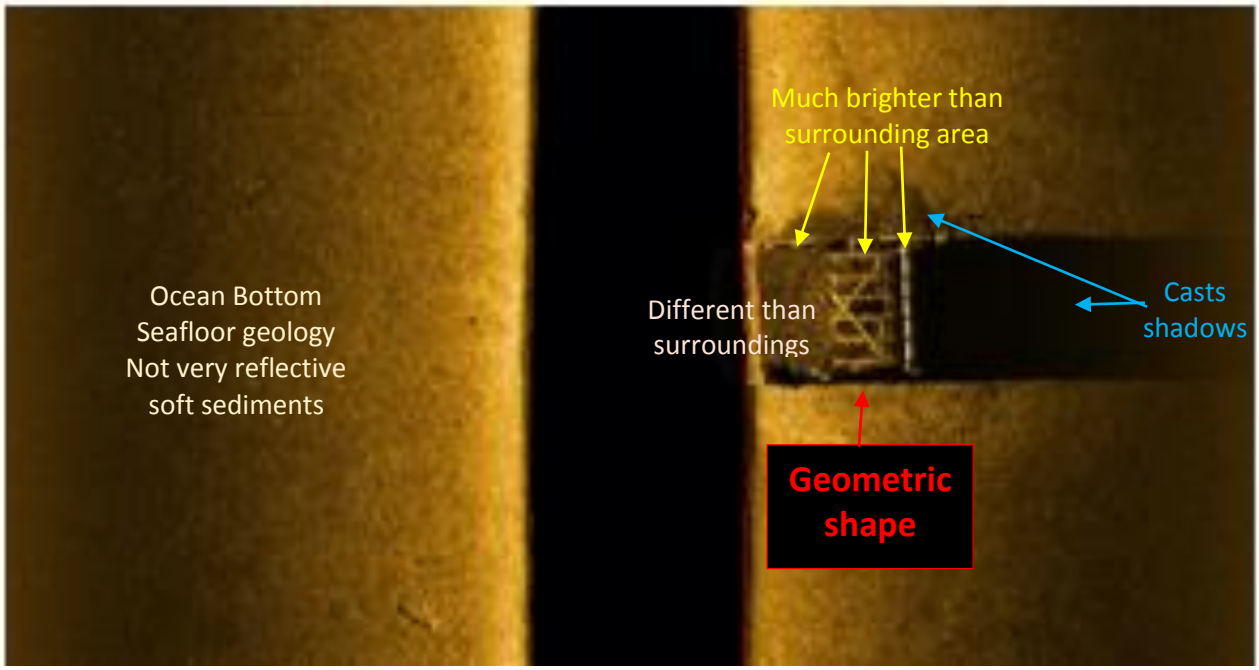
6 – Step Sonar Analysis Criteria for Identifying Man-Made Targets

1. The target's acoustic **reflectivity** is much **brighter** than the surrounding area.	☑ ✓
2. The **size** of the target is about the **right size** for the object.	☐
3. The target **casts a shadow** indicating height above the sea floor.	✓
4. The target is **not** associated or part of the surrounding geology.	✓
5. The target has a **geometric** shape.	✓
6. A **debris field** with multiple objects over a small area might be near the target.	☐

Teacher Analysis Guide for Student Side Scan Sonar Image # 4

Student Teams Side Scan Sonar Image # 4

Q. What do you observe looking at the sonar image?



Side Scan Sonar Acoustic Data Image 25m Range

Directions: Check off any of the man-made object criteria listed in the table below observed in the sonar image. Then, share your observations with your group and be ready to present as a team the observation analysis for your assigned sonar image with the rest of the class.

6 – Step Sonar Analysis Criteria for Identifying Man-Made Targets

	☑
1. The target's acoustic **reflectivity** is much **brighter** than the surrounding area.	✓
2. The **size** of the target is about the **right size** for the object.	☐
3. The target **casts a shadow** indicating height above the sea floor.	✓
4. The target is **not** associated or part of the surrounding geology.	✓
5. The target has a **geometric** shape.	✓
6. A **debris field** with multiple objects over a small area might be near the target.	☐

Name(s) _____ **Date:** _____

Amelia's Last Flight Electra 10-E Special NR16020

Q. What unique identifying features can the Nauticos Expedition team use to identify a target as Amelia Earhart's Electra 10-E Special NR16020?

Amelia's Lockheed Electra 10-E air plane was customized for her last flight mission around the world. The modifications provides the Nauticos Team unique features to look for and use to confirm a found target as Amelia's Electra. The Nauticos Team uses primary resources such as photos, Electra 10 - E Specs and mechanical log reports for identification features.

Directions: Read the information below and highlight, underline or circle the unique features the Nauticos Expedition team can use to identify Amelia's Electra 10 - E when they find it.

Amelia's Electra 10 - E plane has an NR16020 certificate number painted on the wings and on the tail of the plane.

Instead of having passenger seats, Amelia's Electra 10 - E has four auxiliary fuel tanks in the passenger compartment and most of the passenger windows were covered.

The one window not covered up was for her navigator Fred Noonan to look out to get position fixes using the sun during the day and constellation stars at night. Fred's navigation station is another unique feature of Amelia's Electra 10 - E.

Amelia's Electra 10 - E had an RDF (Radio Directional Finder) Loop Antenna.

Amelia's Electra 10 – E was equipped with a Sperry autopilot, radio and navigation equipment. Extra batteries were also in the Electra during the last flight.

With so many unique features the Nauticos Team should have no problem in identifying Amelia's Electra when they find it.

Keep this list handy and look for these features when the Nauticos Team post Sonar and Camera images on the Expedition Portal.

- ☐ NR16020 certificate number printed on the wings and on the tail of the plane.
- ☐ Four auxiliary fuel tanks in the passenger compartment,
- ☐ A navigation station in the rear,
- ☐ Elimination of passenger windows
- ☐ RDF Loop (Radio Directional Finder) Antenna
- ☐ Installation of a Sperry autopilot and various radio and navigation equipment and additional batteries.

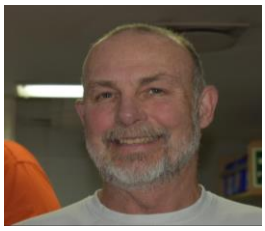
Jon Thompson
Exhibit Manager

In this short video clip, Jon Thompson, Nauticos "Search for Amelia" exhibit manager identifies the unique features of Amelia's Electra 10 E that will help the Sonar Analysis Team identify a target of interest as Amelia's Electra.


Captain Joe, OPS


Jeff Sonar Analysis


Alan, Explorer


Dave Expedition Leader


Spence, Operations


Doc Pam


Elgen Long, Search Advisor

EMAIL THE EXPEDITION TEAM

Email Sallie Smith any questions you have for the Eustace Earhart Discovery "Search for Amelia" expedition team at sea.

sallie@mv.nauticos.rf.org


Tom, Expedition Survey Manager


Rod, Communications HAM Radio


Sallie, Education Lead and Science


Tom, Communications HAM Radio


Bill, Videographer & ED Team

SCHEDULE A SKYPE AUDIO SESSION

(Six Second Audio Delay)

Email Sallie Smith to schedule a Skype Session with your group. Make sure to include your name, location, requested data and time.

sallie@mv.nauticos.rf.org


Bryan, Media Support & IT


Marika, Media, Photographer & ED Team


Jon, Nauticos Exhibits


Greg, REMUS AUV


Mark, REMUS AUV


Neil, REMUS AUV


Sonar Sue, Admin. Logistic & ED Team