Are You My Mother?

Created by the NC Aquarium at Fort Fisher Education Section

Essential Question:

How do researchers determine which female laid each nest?

Lesson Overview:

Students will learn how researchers determine who laid a nest by practicing DNA fingerprinting using actual sea turtle mother and nest DNA fingerprints. They will then graph the data from actual nests found on beaches in the tri-state area (NC, SC, GA).

Learning Objectives:

Students will learn about research being done on sea turtle nests. Students will be able to:

- Explain why researchers need an egg from each turtle nest.
- Match a hatchling's DNA to the mother's DNA.
- Graph DNA data on a bar graph and answer questions about the data.

North Carolina Standards:

Second Grade:

Math:

- **2.MD.D.10** Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put-together, take-apart, and compare problems1 using information presented in a bar graph.

Science:

- **2.L.1** Understand animal life cycles.
    - Summarize the life cycle of animals
        - Birth
        - Developing into an adult
        - Reproducing
        - Aging and death

Technology:

- **2.TT.1** Use technology tools and skills to reinforce classroom concepts and activities.
    - **2.TT.1.1** Use a variety of technology tools to gather data and information (e.g., Web-based resources, e-books, online communication tools, etc.).

Third Grade:

Math:

- **3.MD.B.3** Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories. Solve one- and two-step "how many more" and "how many less" problems using information presented in scaled bar graphs.

Technology:

- **3.TT.1** Use technology tools and skills to reinforce classroom concepts and activities.
    - **3.TT.1.1** Use a variety of technology tools to gather data and information (e.g., Web-based resources, e-books, online communication tools, etc.)

Fourth Grade:

Science:

- **4.L.1** Understand the effects of environmental changes, adaptations and behaviors that enable animals (including humans) to survive in changing habitats.
    - **4.L.1.4** Explain how differences among animals of the same population sometimes give individuals an advantage in surviving and reproducing in changing habitats.

Technology:

- **4.TT.1** Use technology tools and skills to reinforce classroom concepts and activities.
    - **4.TT.1.1** Use a variety of technology tools to gather data and information (e.g., Web-based resources, e-books, online communication tools, etc.).
- **4.RP.1** Apply a research process as part of collaborative research.
    - **4.RP.1.1** Implement a research process by collaborating effectively with other students.

Fifth Grade:

Science:

- **5.L.3** Understand why organisms differ from or are similar to their parents based on the characteristics of the organism.
    - **5.L.3.1** Explain why organisms differ from or are similar to their parents based on the characteristics of the organism.

Technology:

- **5.TT.1** Use technology tools and skills to reinforce and extend classroom concepts and activities.
    - **5.TT.1.1** Use a variety of technology tools to gather data and information (e.g., web-based resources, e-books, online communication tools, etc.)

Time Frame:

Preparation: 30 minutes
Activity 1: 30 minutes
Activity 2: 30 minutes

Materials:

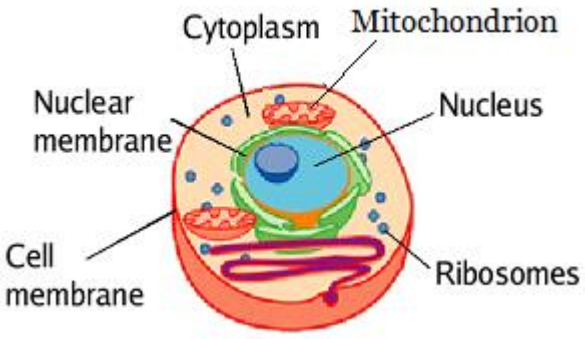
- Fillable plastic eggs (at least one per student)
- Laminated "Mother Turtle" Master sheets
- Printed DNA fingerprint sheets
- Permanent marker
- Bin
- DNA Worksheet
- Computers with internet access
- Butcher paper or white board

Preparation:

Print one copy of each of the "Mother Turtle" sheets. These should be laminated and hung on the wall. Print enough copies of the DNA fingerprint sheets to fill each egg with one fingerprint. Cut out the fingerprint sheets. Put one fingerprint in each egg. Label the eggs "Nest 1", "Nest 2", etc. Each egg should have a unique nest number. Place the eggs in a bin. Print extra copies of the fingerprint sheets to model matching to the students- these will be used show the students what characteristics to look for when identifying a parent/offspring pair. These can be laminated as well. Print a copy of the DNA worksheet for each student. Create blank bar graphs using butcher paper for each of the following data points: number of nests, number of DNA samples, number of individual females, and largest number of nests laid by one female. You can label the beaches along the x-axis or allow the students to fill in that space. The y-axis should be numbered 1-n (n being the largest number in the data set). These will be hung on the wall for the students to fill in.

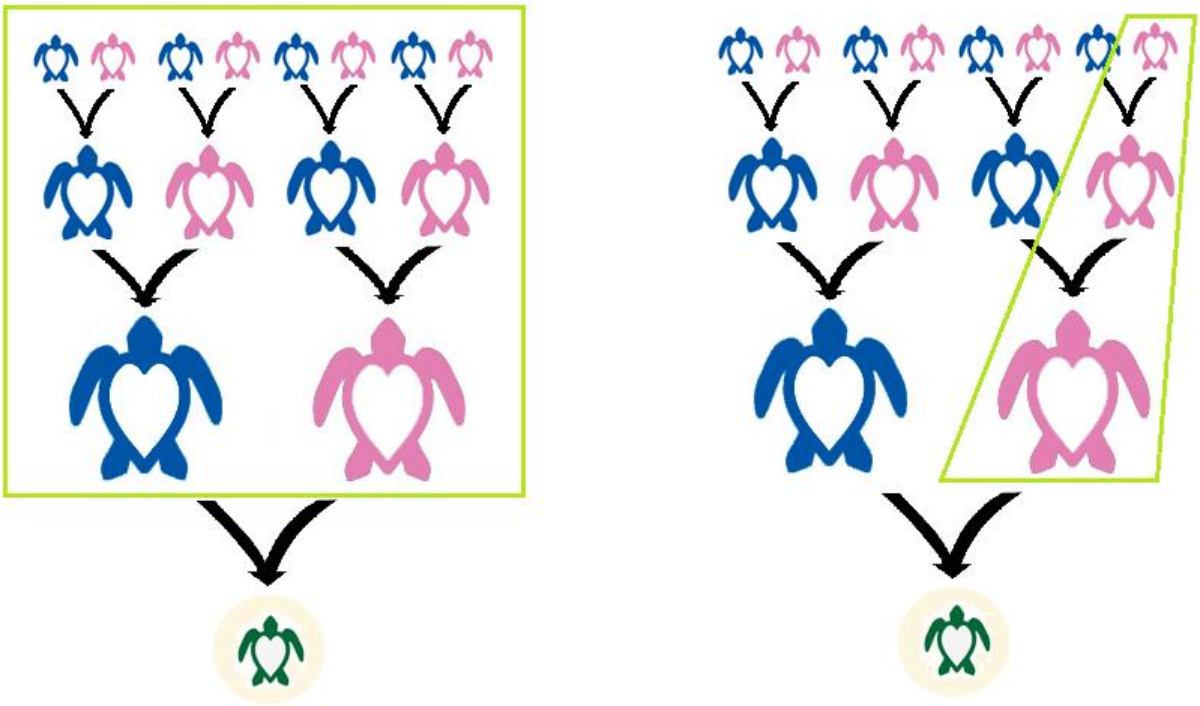
Supplemental Background Information for Teachers:

Sea turtle groups in North Carolina are participating in a tri-state research project on nesting females. This project collects one egg from each nest to use for research purposes. Scientists use the DNA found in the mitochondria of each egg. Within every animal cell is a variety of organelles, one of which is the mitochondrion.



Mitochondria are cellular powerhouses. Because mitochondria are larger organelles, they are only passed on to offspring through the mother's egg cell. Therefore, DNA in the mitochondria

only comes from the mother. This can be used to trace family lines through the female members.



Cellular DNA comes from all ancestors. Mitochondrial DNA comes from the female line.

Using this information, researchers are trying to find the answers to a variety of questions. Here is the information on the project from www.seaturtle.org/nestdb/genetics:

> The Georgia and South Carolina Department of Natural Resources and the North Carolina Wildlife Resources Commission Sea Turtle Programs are participating in a multi-state genetics research project along with the University of Georgia to answer several basic loggerhead sea turtle nesting questions. The answers to these questions will help biologists better understand how the loggerhead population is doing. Currently, the actual number of loggerhead sea turtles that nest in these three states is not known (loggerheads nesting in these three states make up the Northern Recovery Unit which is genetically distinct from loggerheads nesting in Florida and other parts of the world). By collecting an egg from every single nest, [the study] will use DNA genetic fingerprinting (CSI for sea turtles) to identify individual loggerhead nesting females. This information will provide a census of the actual nesting population. In addition to estimating how many females are nesting in Georgia, North and South Carolina each year, [the scientists] also have the potential to answer the following questions:
>
> - How many clutches of eggs does each nesting female lay in a year?
> - Is the female nesting on more than one beach?

- How far apart are her nests?
- How many turtles are nesting in more than one state?
- Most individual females do not nest every year. How often does each turtle nest: every two years, three years, four or more years?
- How precisely does a daughter return to her hatching site to lay her eggs?

For more specific information, please visit: www.dnr.sc.gov/seaturtle/volres/genetics.pdf

Procedure:

Activity 1:

1. As a class, review the process sea turtle organizations use to monitor nests (find the nest, move it if necessary, mark it off, watch the nest, prepare for hatching, excavate the nest). This information is discussed in other lessons which can be found here: seaturtleexploration.com/teacher-resources/lesson-plans/.
2. Ask the students to pretend they are sea turtle nest researchers. As a class, create a list of questions they would like to answer about sea turtles and their nests.
3. Introduce the class to the research being done in Georgia, South Carolina and North Carolina. Did they come up with any questions that the study is trying to answer? You can find the list of questions here: www.seaturtle.org/nestdb/genetics.shtml.
4. Explain to the students that they will be helping scientists to identify some turtles using DNA fingerprints.
5. Have the students look at their fingers and talk about the fact that everyone has different fingerprints. Every person and animal also has different DNA fingerprints (unless they are identical twins) so this can be used, just like real fingerprints, to identify specific individuals.
6. Tell the class that they have received a shipment of eggs collected from sea turtle nests along the North Carolina Coast. Each egg comes from a different nest. Their job is to identify which mom laid the egg based on its DNA fingerprint.
7. Explain to the class that, while most of the DNA in your body is a combination of both of your parents' DNA, the DNA in part of your cell only comes from your mother. This is called mitochondrial DNA and for every animal, this only comes from the mother. Using this we can identify which mother turtle laid which nest.
8. Show examples of the "Mother Turtle" fingerprints. Use the model egg fingerprints to show the students how to match the egg fingerprint to the mother fingerprint. For each image, the students will be matching the spike location and height. They will have to look carefully, as several are similar.
9. Once the students understand what they are looking for, have them each select an egg from the bin.
10. The students will open their egg and walk to each of the "Mother Turtle" fingerprints hanging on the wall. Once they have matched their DNA, they should stand to the side of their "parent" until everyone has finished.

11. Have the students compare their fingerprint with the other students in their group to self-check.
12. You can have the students place their fingerprint back in their egg and then back into the bin. The students can then select another egg to match.
13. Lead the class in a discussion on the process. Was it easy or hard to match the fingerprints? Would it be harder if there were hundreds of turtles? The study currently includes over 1225 unique female fingerprints.

Activity 2:

1. Now that the students have identified their mother turtles, it is time to look at the data collected on these females.
2. Inform the students that they will be collecting data for different beaches.
3. Pass out the DNA worksheet.
4. Assign each student a beach. A list of beaches can be found by visiting this website: www.seaturtle.org/nestdb/genetics.shtml (be aware that this site is sometimes slow to load). Then select the state and beach. Have them write their beach on their worksheet.
5. Have the students use the website to answer the questions on their worksheet.
6. While the students are working on their worksheets, hang the bar graphs on the wall.
7. When the students are finished, have them find their beach on each of the graphs and fill in their data.
8. When all of the students are finished, answer the following questions as a class: Which beach had the largest/smallest number of nests? Which beach had the largest/smallest number of DNA samples? Which beach had the largest/smallest number of individual females? Which beach had the largest/smallest number of nests laid by one female?

Extensions:

1. Have the students complete another copy of the worksheet for the same beach but for a specific year. Have the students graph and compare specific years to the total data found on the first page.
2. Follow the data over the course of the year and add to your graphs as new data is added.

Sea Turtle DNA Fingerprinting

My beach is _____ in the state of _____.

1. The number of nests studied on this beach is _____.
2. The number of DNA samples taken is _____.
3. The number of individual females nesting on the beach is _____.
4. The number of females with only one nest is _____.
5. The female with the most beaches visited went to _____ different beaches.
6. Click "View" next to "Maximum Number of Beaches Visited". What other beaches did that female visit? _____

   _____

   _____

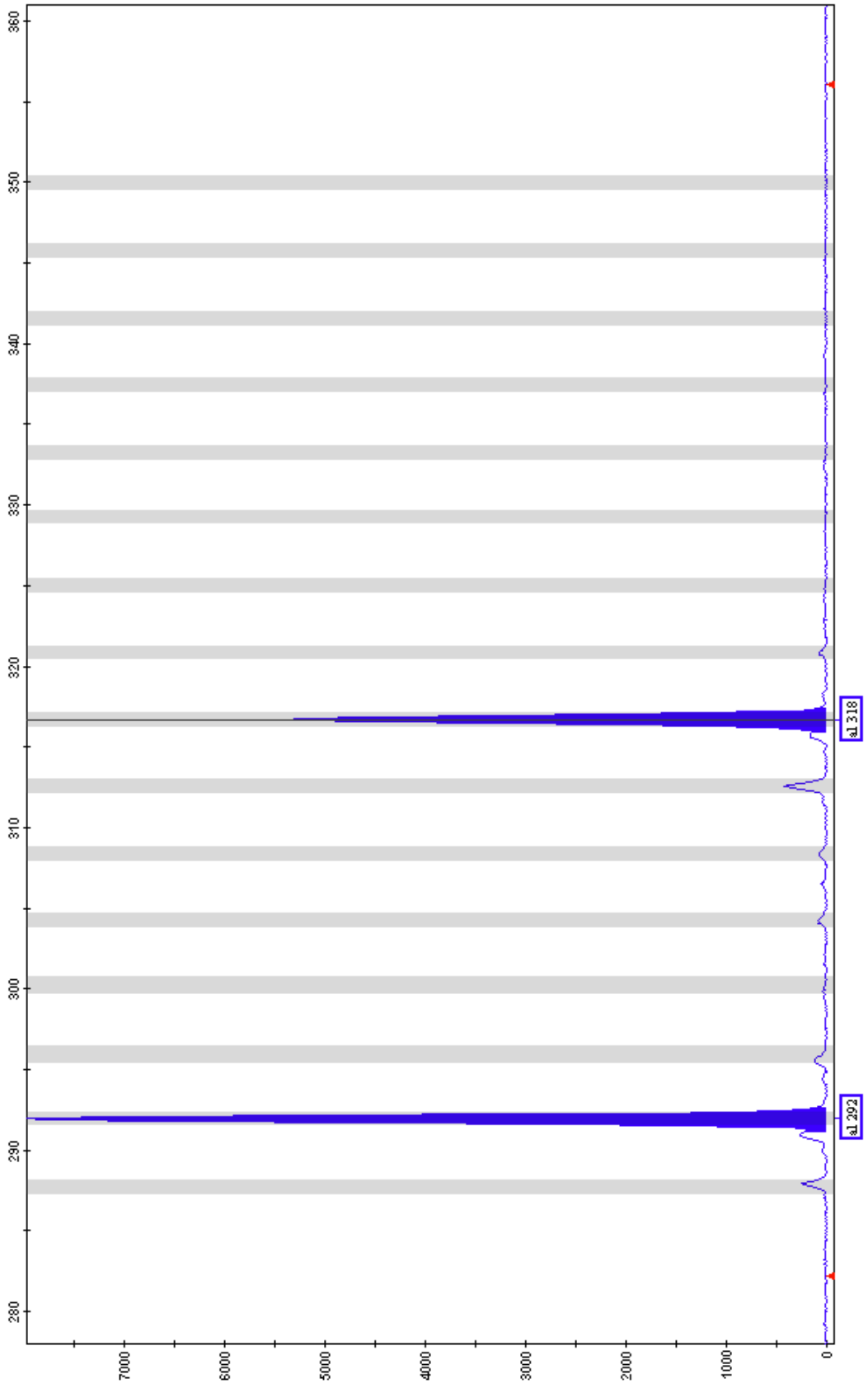
   _____
7. On average, how many nests did each female lay? (Nests per Female) _____
8. What was the largest number of nests laid by one female? _____
9. Click "View" next to "Maximum Number of Nests". On what beaches did the female with the largest number of nests lay eggs? _____

   _____

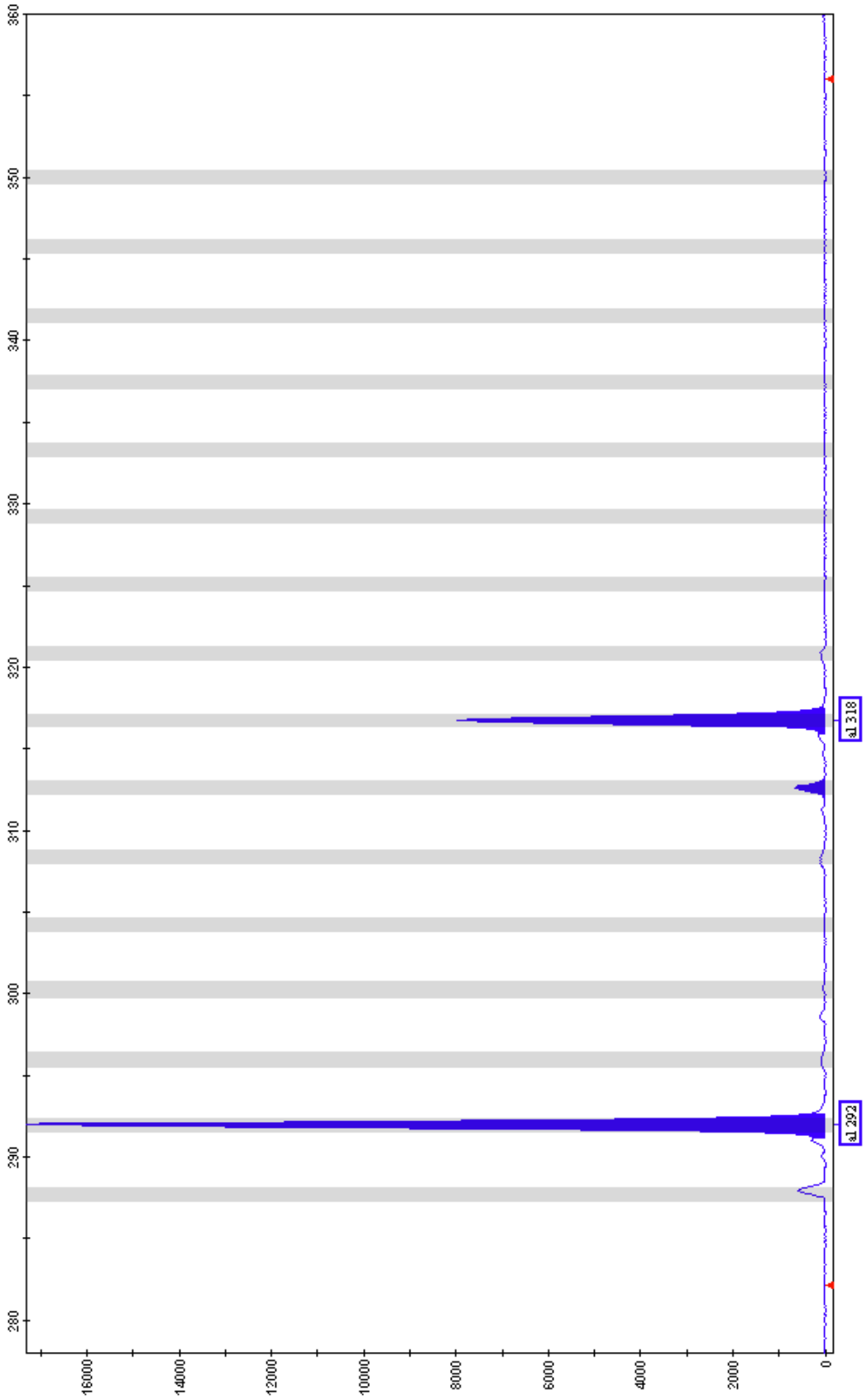
   _____

   _____
10. What was the average number of days between nests for the female turtles? (Mean Internesting Period)? _____

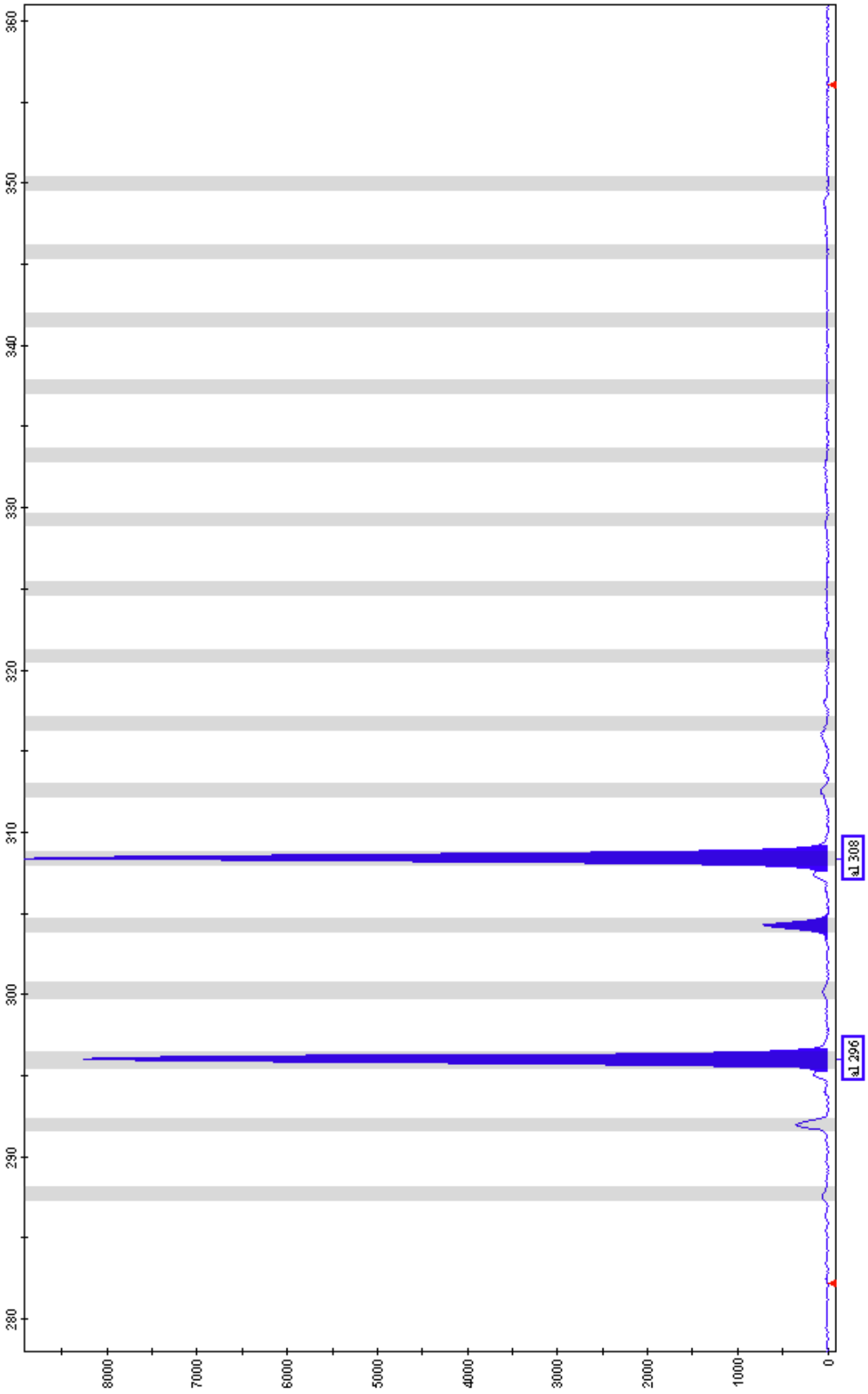
Mother Turtle 1

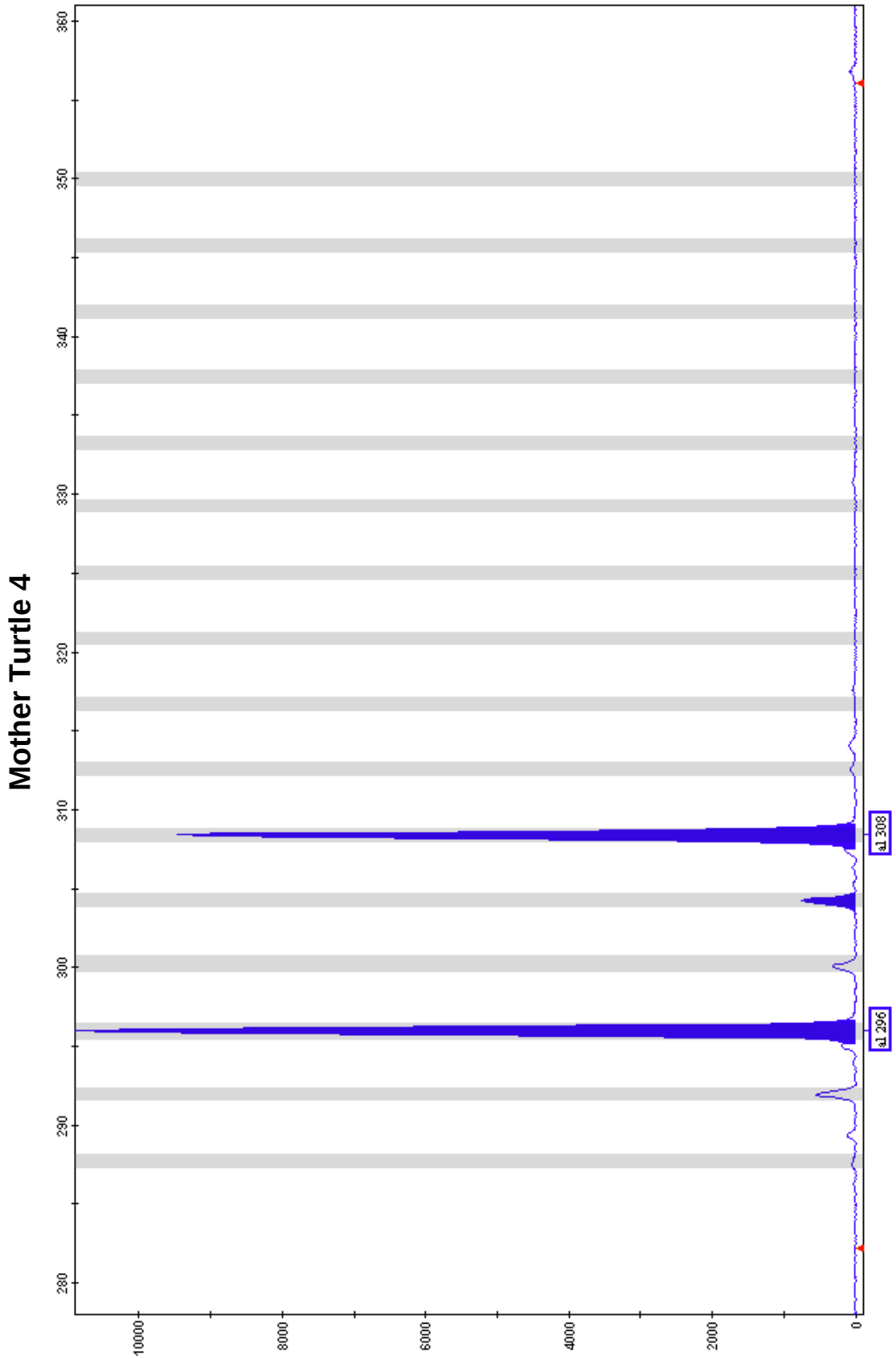


Mother Turtle 2



Mother Turtle 3




Mother Turtle 4
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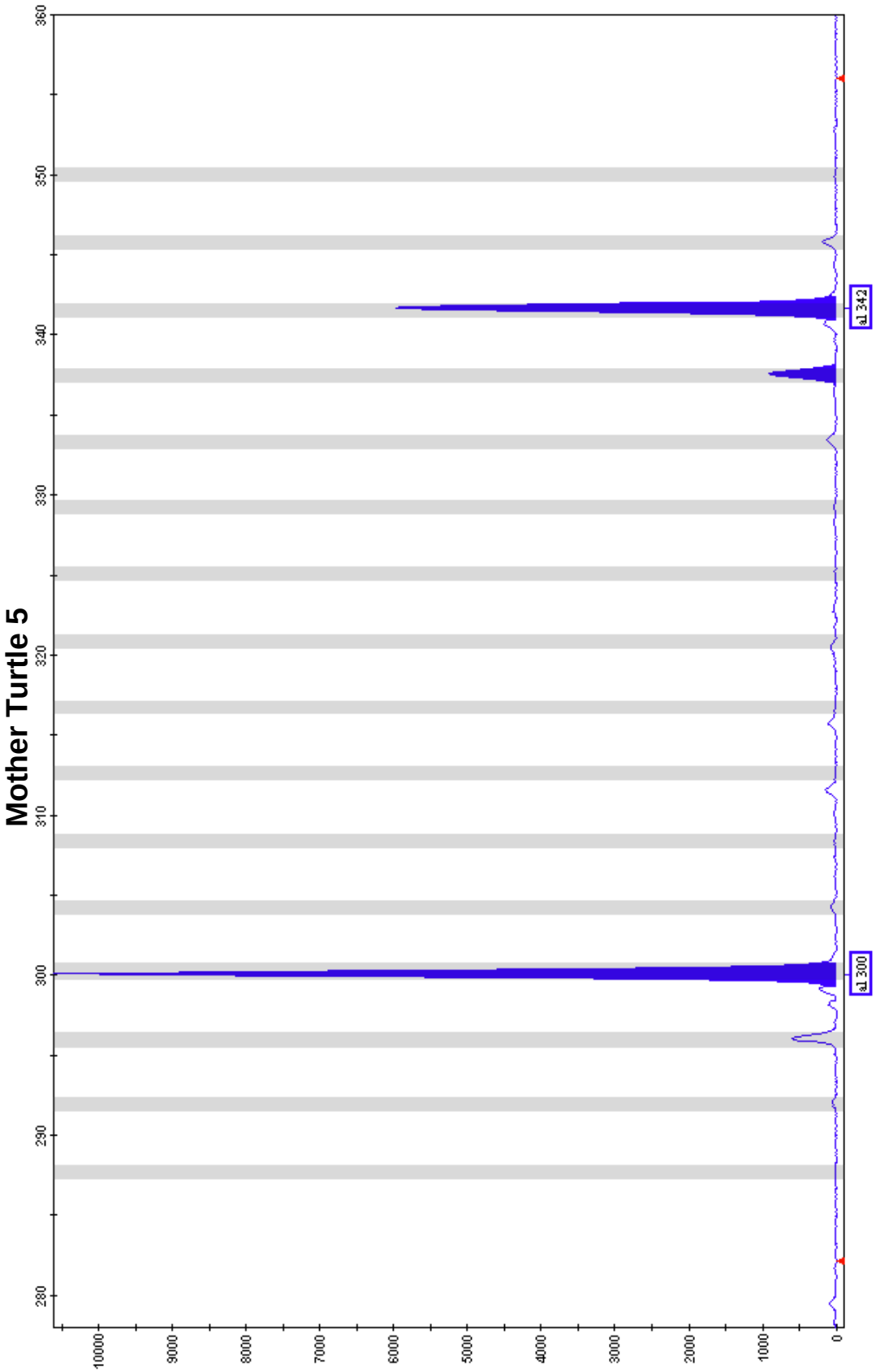
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a1 300
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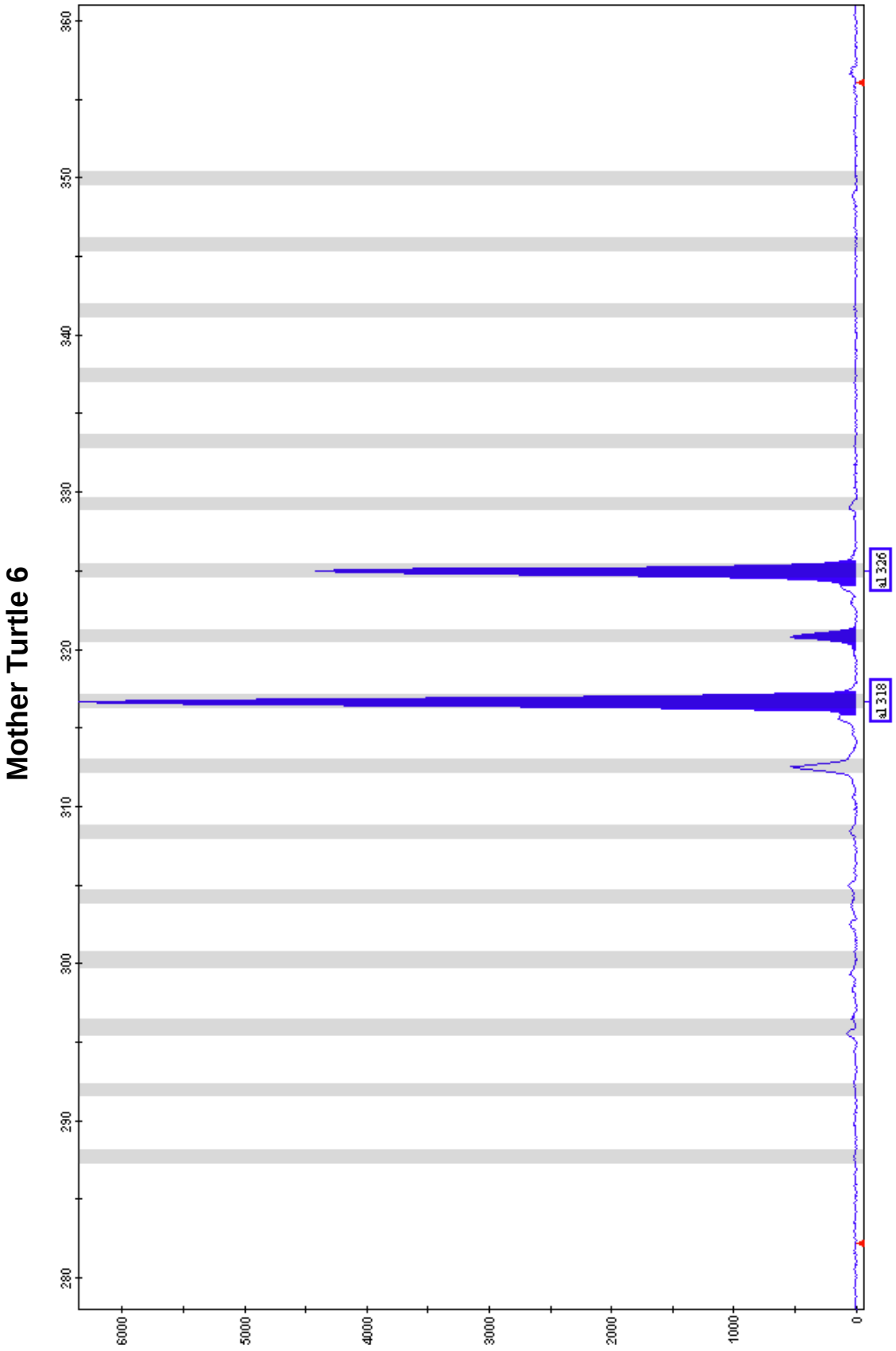
Mother Turtle 6
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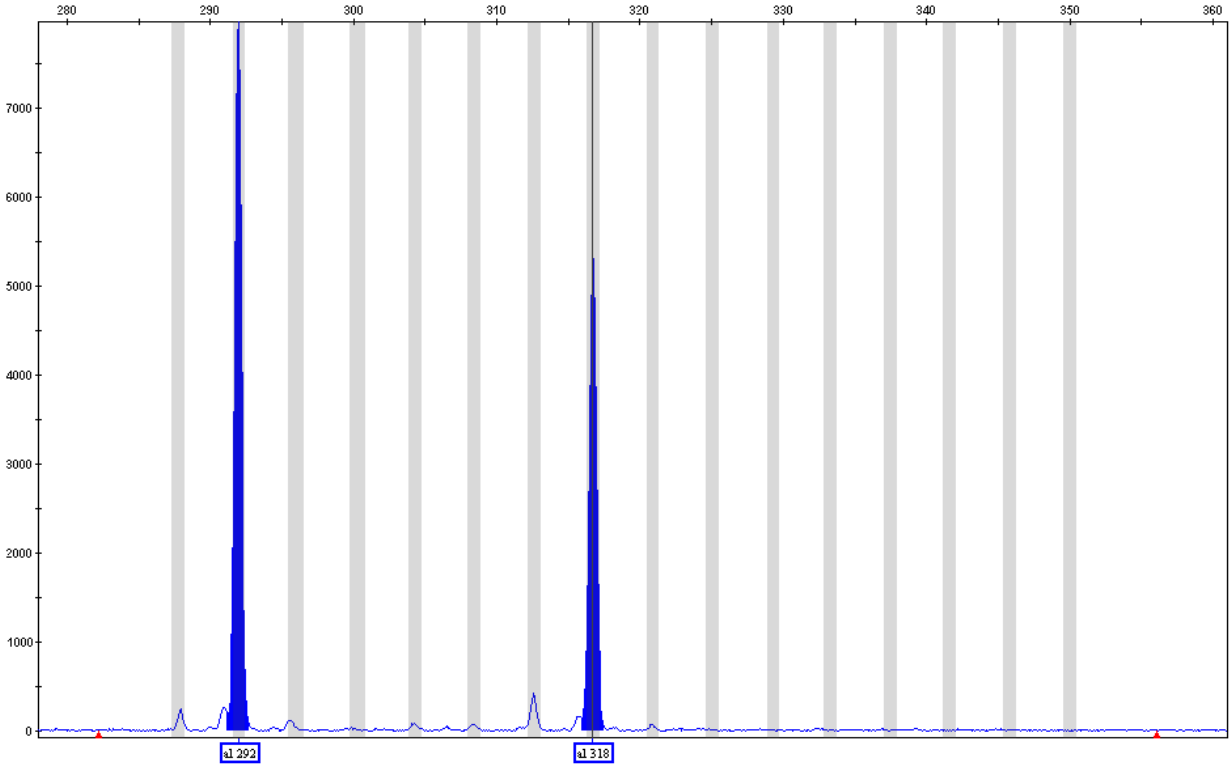
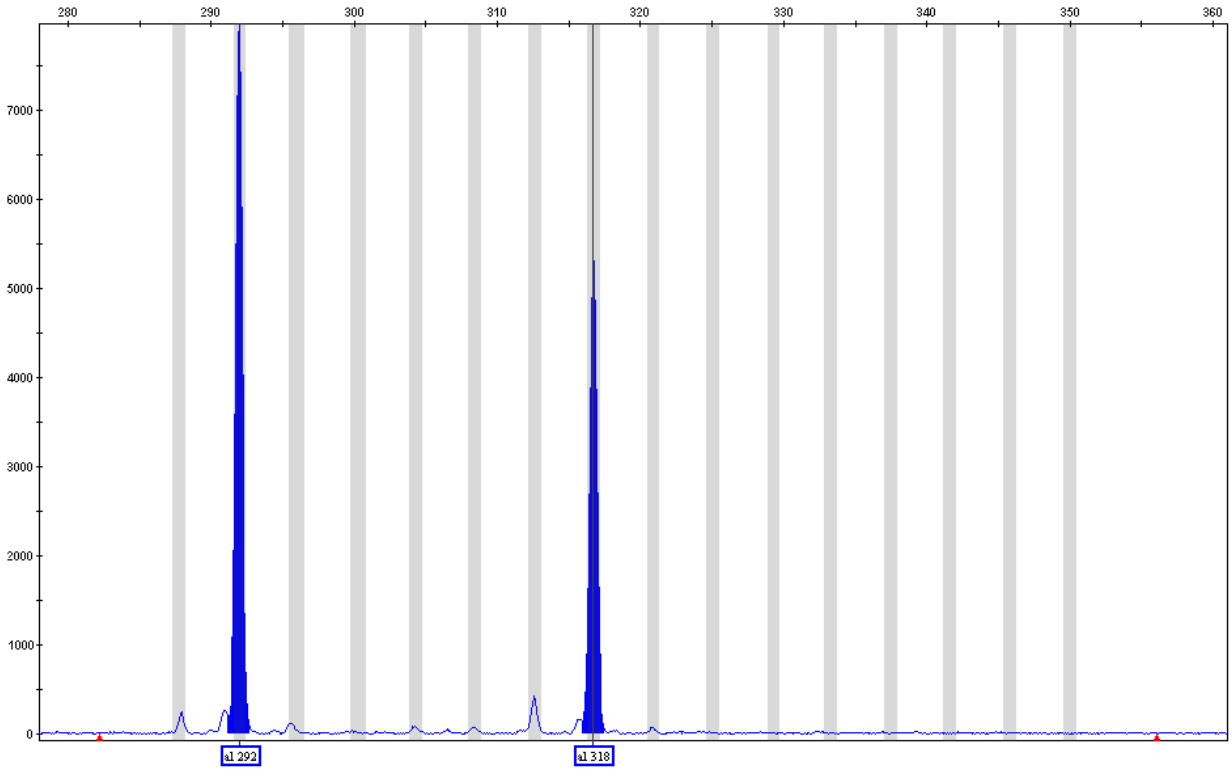
a1 326
a1 318

DNA Fingerprint 1





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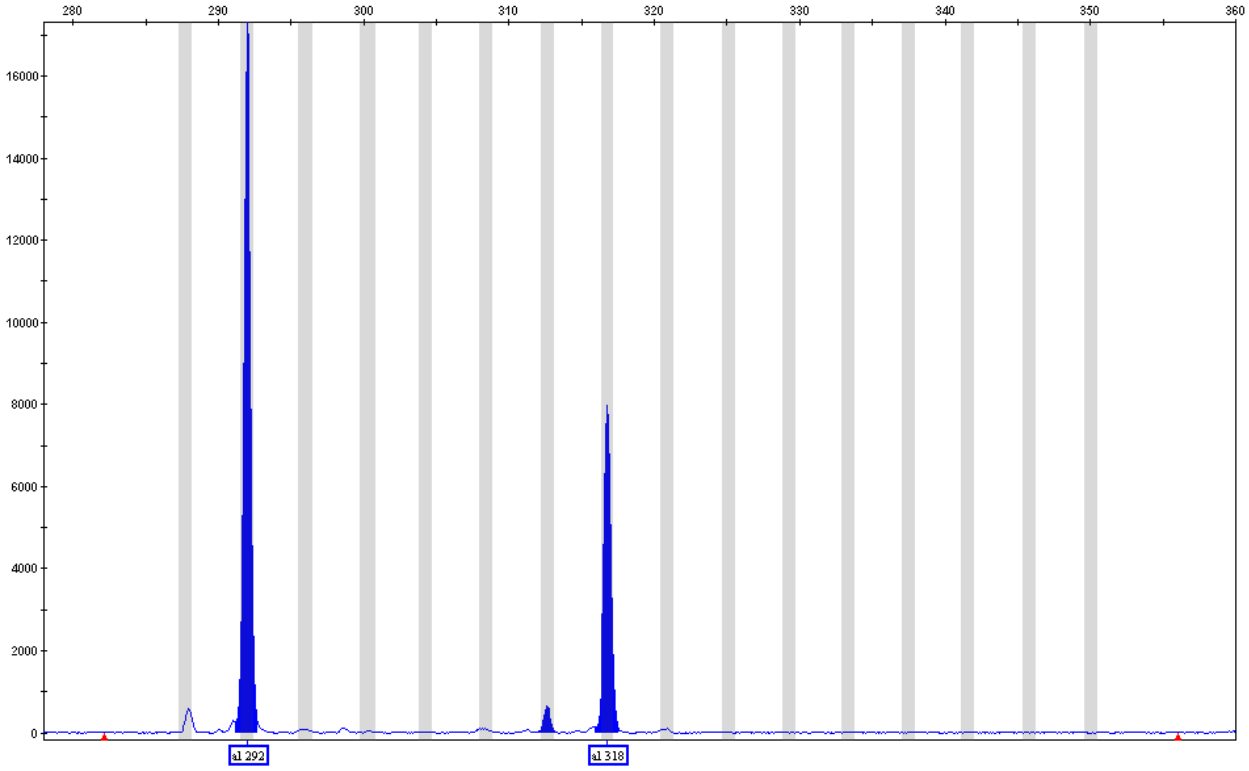

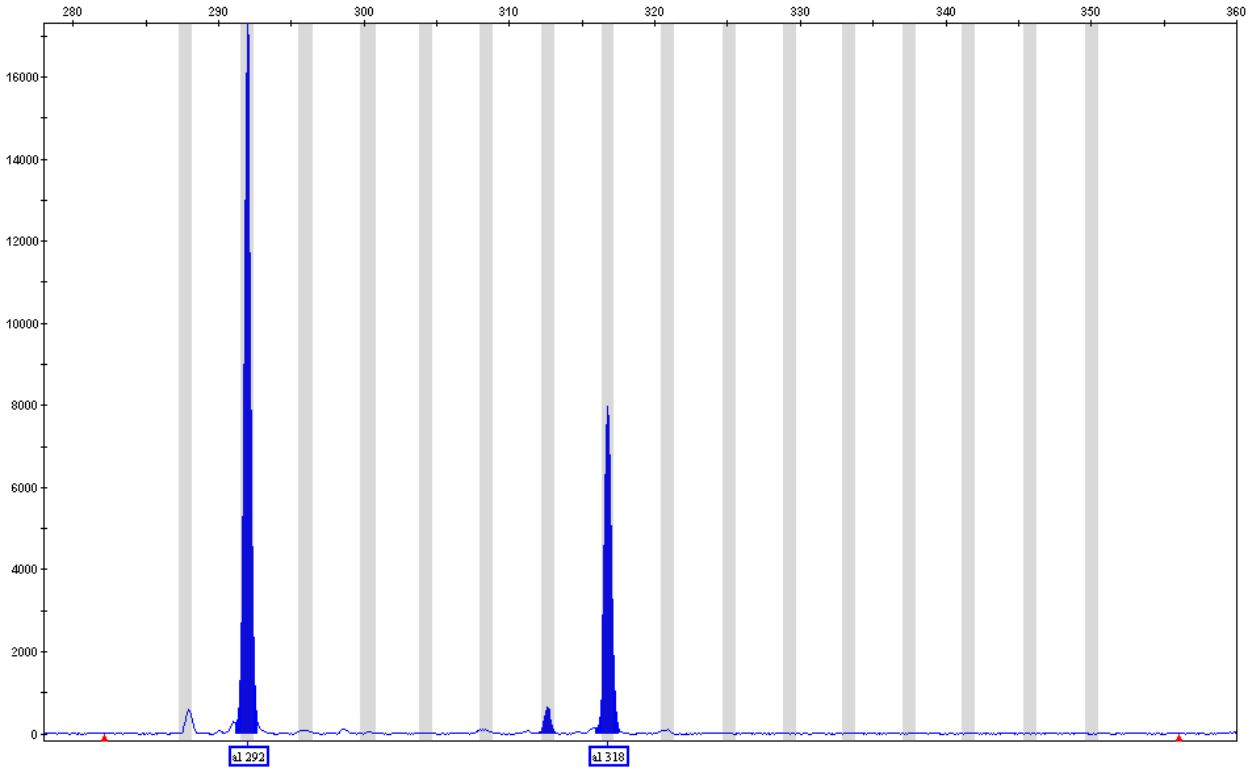

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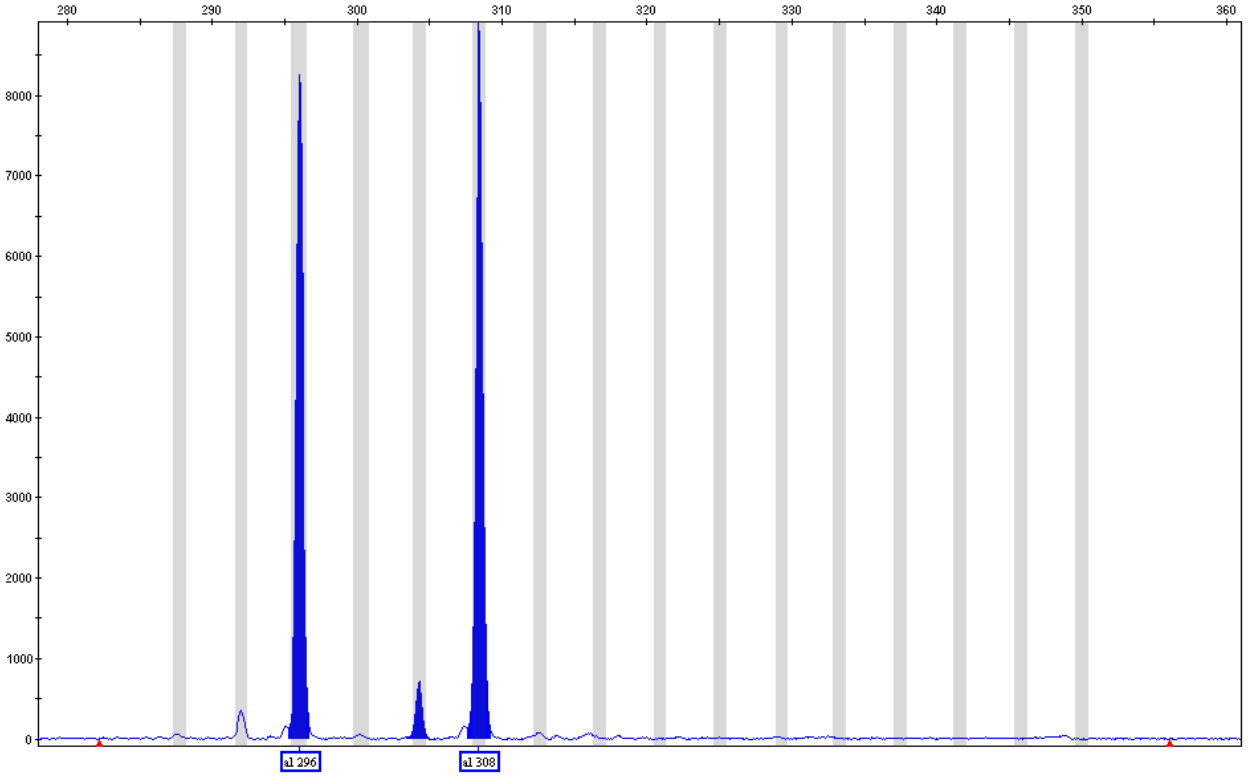
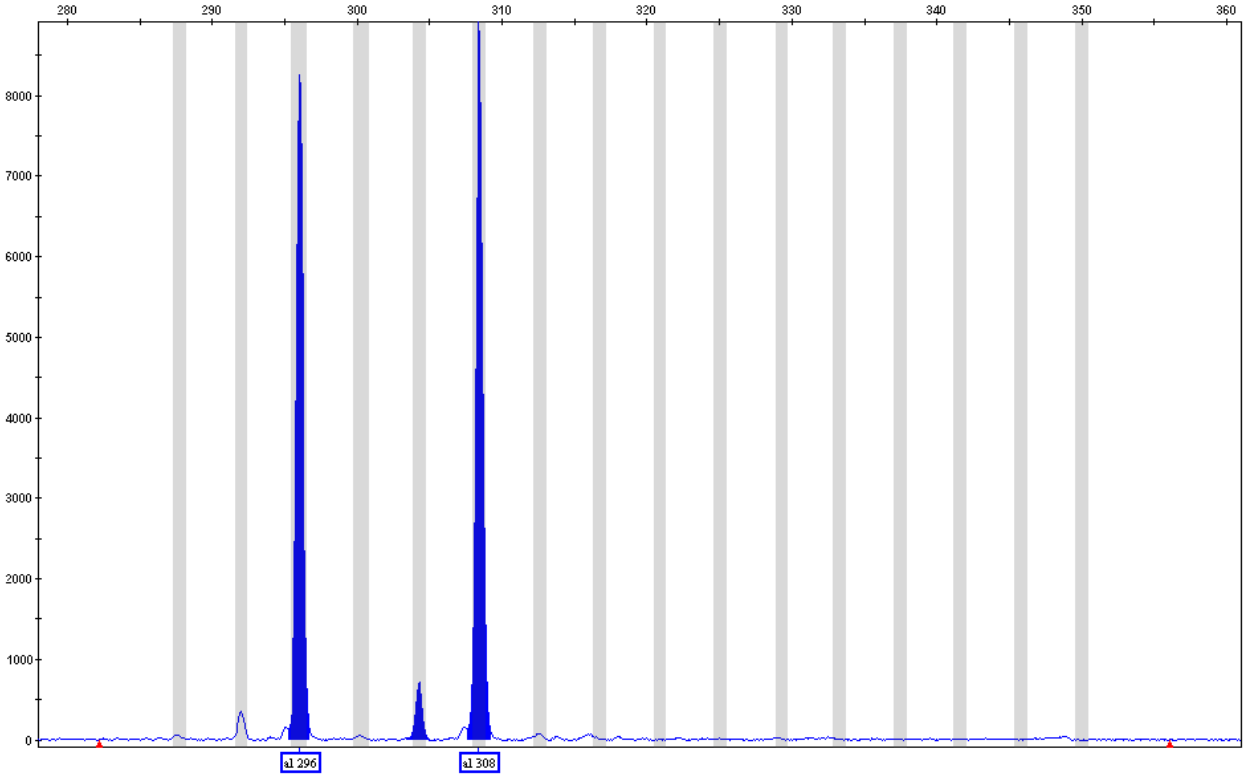
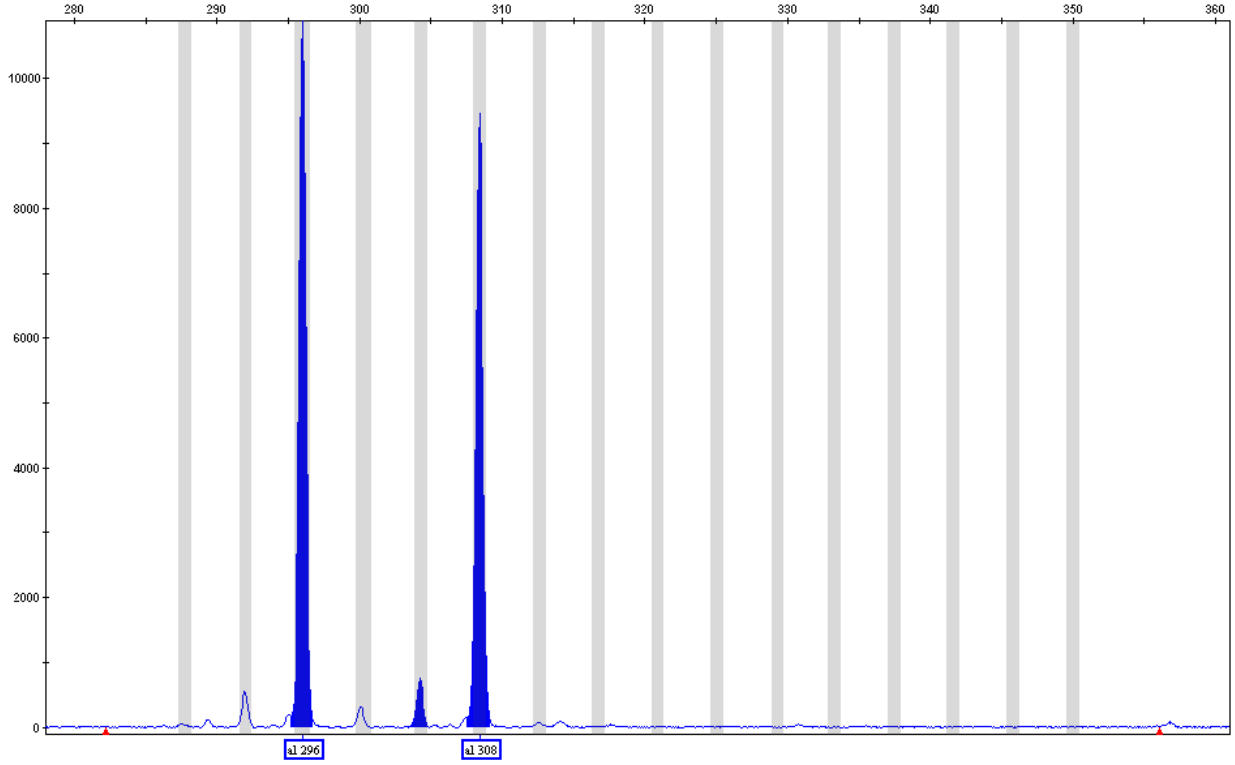
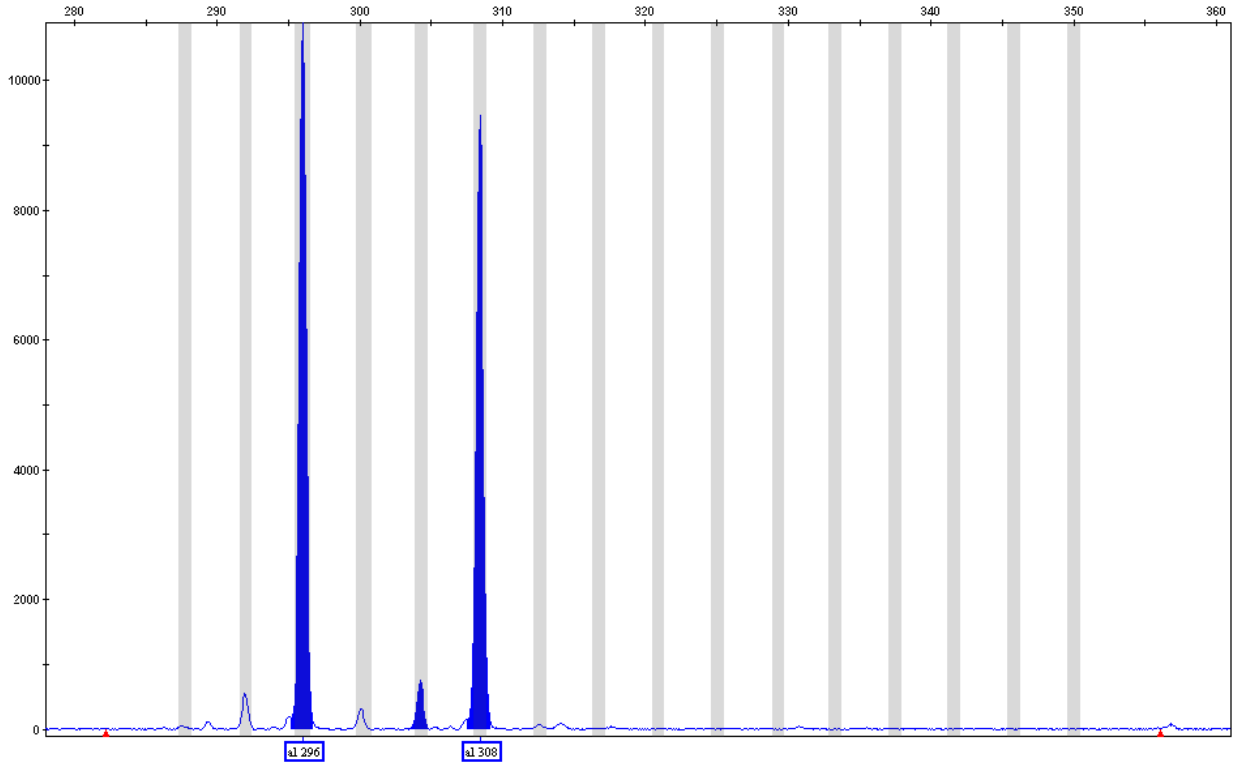


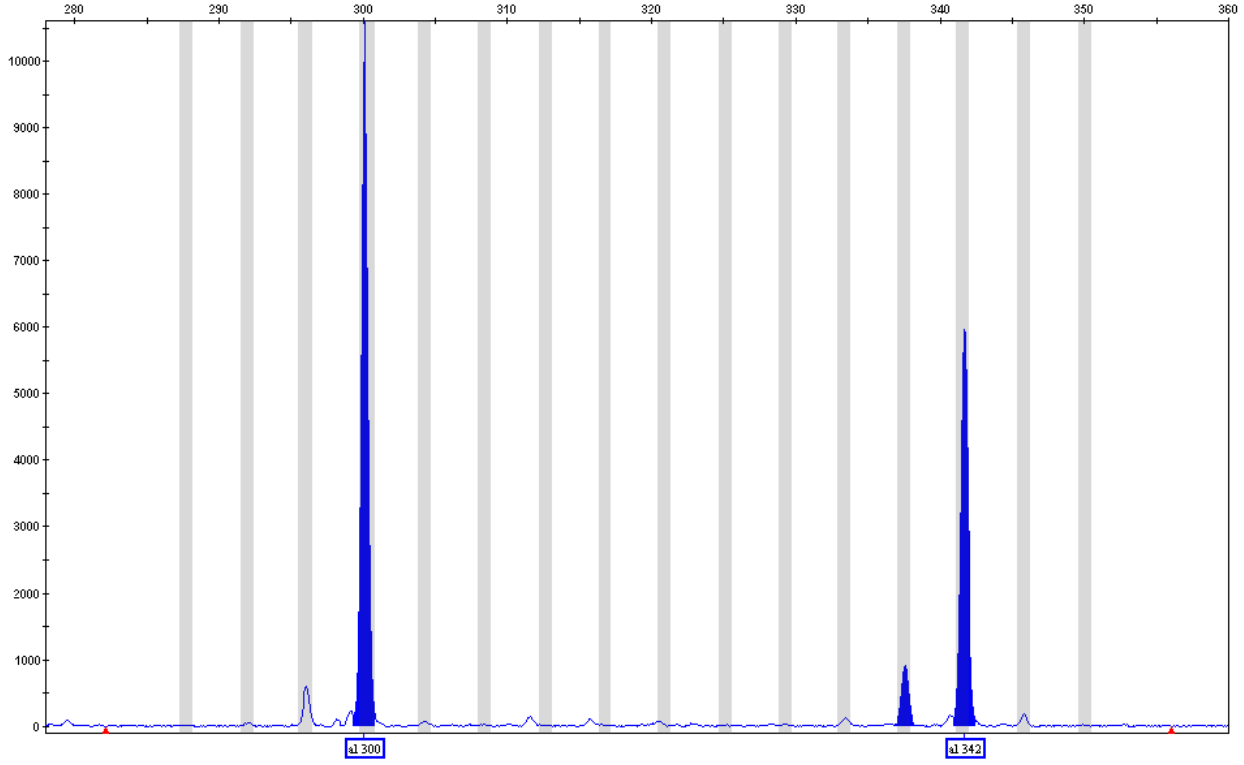


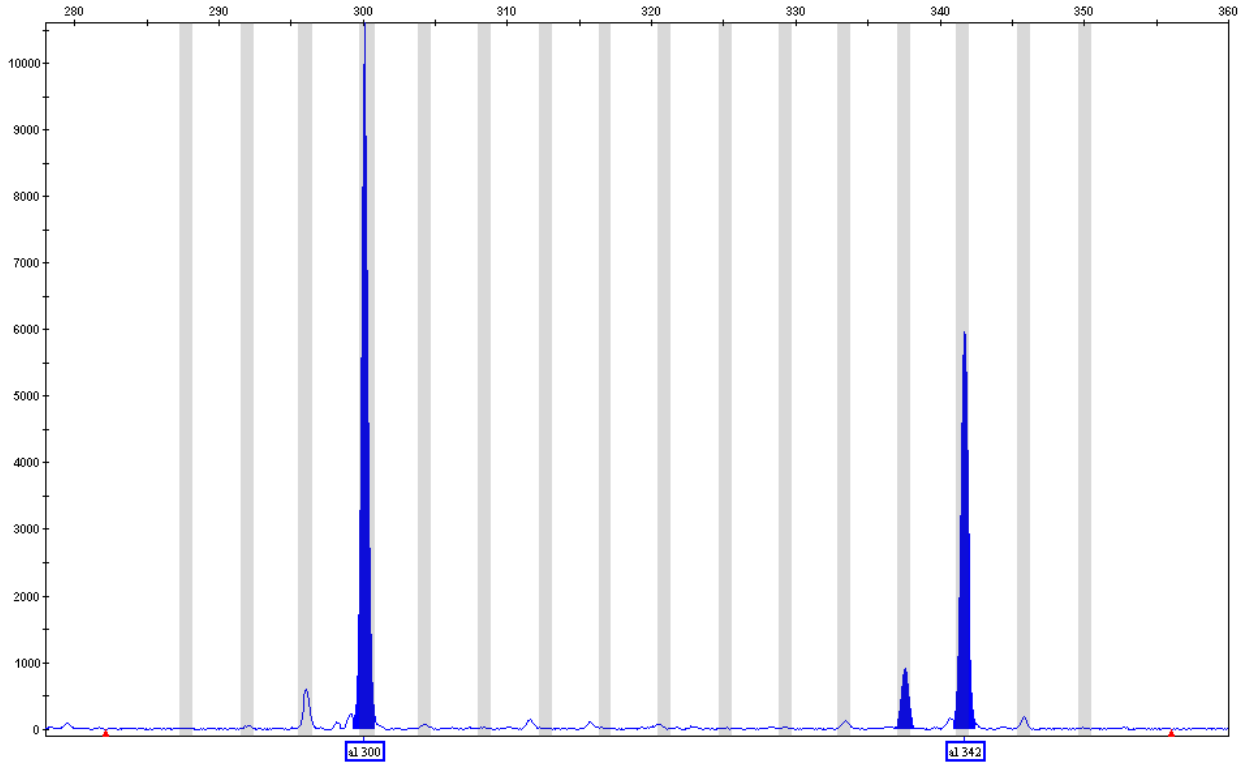
DNA Fingerprint 4





DNA Fingerprint 5





DNA Fingerprint 6