Topic: How a Sailboat Works: *Hull Type*

Primary Goal: After this lesson, students should be able to determine the proper hull designs necessary to compliment the various rigs.

Lesson Objectives:

- Students will learn the various hull designs and compare and contrast
- Students should understand the pros and cons to earlier sailboat designs
- After this lesson, students should be able to reference ancient designs and effectively integrate them into their own design later in the course

Lesson Outline:

I. A sailboat's hull is important for many reasons, including the following:
  - **a.** Stability
  - **b.** Safety
  - **c.** Comfort at Sea
  - **d.** Load Carrying Capacity
  - **e.** Speed

II. Sailboats can be identified by the number of her hulls
  - **a.** Monohull – single hull
  - **b.** Catamaran – 2 hulls
  - **c.** Trimaran – 3 hulls
  - **d.** Discuss how multi-hull boats are generally faster than monohull sailboats
    - **i.** There are many reasons, but one primary reason is the reduced drag. A multihull does not need additional weight or ballast for stability since it has multiple hulls and thus a wider beam (breadth).

III. Keel
  - **a.** Full Keel
    - **i.** Pros – easy to steer on a straight course through the water and not as sensitive to minor course adjustments
    - **ii.** Cons – slower to turn and increased drag due to large amount of surface area below the waterline
  - **b.** Fin Keel
    - **i.** Pros – turns quickly around the keel and able to adjust course faster than a full-keel
    - **ii.** Cons – smaller keel provides less resistance to forces that could cause a sailboat to go off course. Helmsman must be attentive when at the helm.
  - **c.** Bulb Keel
    - **i.** Provides more ballast weight by concentrating a large amount of weight
    - **ii.** This can help improve a boats stability

- **d.** Winged Keel
  - **i.** Provides additional hydrodynamic stability
  - **ii.** A winged keel sailboat has the added benefit of stability while also maintaining a reasonably shallow draft capable of sailing in shallow water

IV. Hull Displacement
- **a.** The amount of water a sailboat shoves to the side while floating
- **b.** The weight of a sailboat is equal to the weight of the water it displaces
  - **i.** Discuss the difference in weight between salt water vs. fresh water (salt water weights slightly more than fresh)

V. Displacement – Length Ratio
- **a.** A measurement used to describe whether a boat is a heavy or light displacement hull
- **b.** This can help tell a boat's purpose and performance
  - **i.** Light Displacement Hull – 200 or less
  - **ii.** Medium Displacement Hull – 200-350
  - **iii.** Heavy Displacement Hull – 350 or more
- **c.** When calculating the D/L ratio, it is important to use the sailboat's Load Waterline Length (LWL)
  - **i.** This is the hull's length where it comes out of the water at the bow and the stern
  - **ii.** This is critical, because it measures the length of the boat that is exposed to the water
- **d.** Racing Sailboats will generally have a much lighter D/L ratio

VI. Ballast – Displacement Ratio
- **a.** The weight in the keel and bottom of the boat that counter's the sailboat's tip or "heel"
- **b.** This is a good indicator of the stability of the sailboat and can help tell us the boat's purpose (offshore cruising vs. racing)
- **c.** By comparing a boat's ballast to her displacement, you can make this determination
  - **i.** Coastal – 35% or less
  - **ii.** Average – 35% - 45%
  - **iii.** Offshore – 45% or greater
- **d.** These measurements do not hold true for all boats, but can be used as a general guideline

Exercises/Activities:

Provide students with a worksheet showing the different sailboats and allow the students to perform the various calculations.