I. A population \( P_t \) of mussels reproduces annually with an intrinsic rate of increase \( r \) of 3%. Harvesting removes \( h = 60 \) tons a year.

a. Write the updating equation for this discrete process; that is write \( P_{t+1} \) in terms of \( P_t \) and numbers.

\[
P_{t+1} = P_t + 0.03P_t - 60 = (1.03)P_t - 60
\]

b. Is there an equilibrium value for this population? If so, compute it.

- Yes
- No

Value: 2000 tons

\[
P_t = P \quad \text{condition for equilibrium}
\]

\[
(1.03)P_t - 60 = P_t
\]

\[
0.03P_t = 60
\]

\[
P_t = 2000 \text{ tons}
\]

c. Write the updating equation as you would enter it in your calculator.

Hint: It will have the form \( u(n) = (1.03)u(n-1) + h \) or \( u(n) = u(n-1) + (0.03)u(n-1) + h \).

\[
u(n) = 1.03u(n-1) - 60
\]

d. If the population is currently 1000 tons, what will it be in 23 years? in 24 years? How do you interpret what is happening?

Let the calculator do the work! Somewhere between 23.

\[
u(23) = 26.4 \quad u(24) = -32.8
\]

e. If the population is currently 3000 tons, what will it be in 6 years?

\[
u(n_{Min}) = 3000 \quad u(6) = 3194
\]

f. (Bonus) Is the equilibrium value (assuming that there was one) stable or unstable? Explain, perhaps using a graph to help.

Unstable- if we start \( P_0 \) above 2000, \( P \) gets larger and larger. If we start \( P_0 \) below 2000, then \( P \) falls to 0. In either case the pop. does not return to 2000.