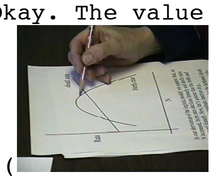
0:09:54 - Eco. Dynamics Graph

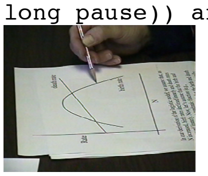
A: Do you want me to read it out loud?
D: Sure, if you'd like to
A: Okay, rate, N in our derivation of the logistic model we assumed that birth rates declined linearly ((pause)) and death rates increased linearly now let's assume that the birth and death rates follow a quadratic function e.g. b = b = $B_0 + (k_b)N - (k_c)N^2$ such that the *birth* and *death* rates look like the *figure*. Such a function is biologically realistic if, for example, individuals have trouble finding mates when they are at very low density. Discuss the implications of the birth and death rates in the figure, as regards the conservation of such a species. Focus on the birth and death rates at the two intersection points of the lines (PICTURE 0.11.36) and on what happens to population sizes in the zones of population size below, between and above the intersection points. ((Pause. In-breath. Brief laughter)) I can hardly absorb what that *means*. °Discuss the implication of the birth and death rates in the figure, as regards conservation of such a species. ((pause)) Focus on the birth and death rates at the two intersection points of the *lines*, and on what happens to population sizes in the zones of population size below, between, and above the intersection points.° ((Move pencil along text)) ((long pause)) So the first sentence is not relevant to this right? I am having trouble getting out ((movement along text with pencil)). Let me move it further away. ((Literally moving paper further away.)) What's here? ((Long pause)) ((2:29)) As regards to *con*servation of a certain species. ° and on what happens to population sizes in the zones of population size° Okay. SO ((puts paper down on table)) *here* ((pencil to the graph)) we have the *death* rate increasing (PICTURE 0.12.35) and the birth rate increasing (PICTURE 0.12.41) and the birthrate is increasing faster than the death rate. So they are both increasing but the birth rate is faster increasing than the death rate so presumably *that* means that the population is *in*creasing. (PICTURE 0.12.58) ((3:00)) Is that right then?
D: Um
A: () Down in this region?
D: Well, yeah, if you take birth and death, the birth minus the death, well, the birth plus the death which is negative, you are gonna get something positive, a growth rate, right?
A: =*I'm* looking at the slopes of the curves.
D: Oh, okay. ((3:16))
A: ((long pause)) Okay ((pencil to the graph)) °what happens to population sizes in the° *zones* of population be*low*, bet*ween* and ab*ove* the intersection points. So I was looking just above the intersection points. Wasn't I? That's what I felt I was doing just then.
D: Uh hmm. That's correct.
A: But then the ah— *before* that ((long pause)) the— the birthrate was *low*er than the death rate (PICTURE 0.14.02) and so it seems to me that the population was decl*in*ing. ((Pause)) Is that right? ((4:09))
D: ((Pause)) Um
A: I am looking at this region here ((pencil circles region below intersection 1)) now.
D: Yeah ((hesitatingly) that— I think that's correct. Is that what it says on the graph? ((Pause)) ((Anne's hand on the graph)) °Or°
A: You mean here ((hand moves down to the text))?
D: Yeah, [does it say—?
A: [You want me to look there? ((points to text))
D: No, I mean, is it—?
A: Hmm
D: Is it that what you are— or is that your personal observation?
A: °B-(zero? plus?)°— *B*, what are these variables? *N* is here ((points to the graph)), what's little b?
D: Uh
A: ((reads from text)) °birthrate follows quadratic function°
D: that's just an example of a quadratic function
A: Ah, okay.
D: And the *N*

A: =Look
D: *N* is the population den[sity
A: [Yeah, no I see that.
D: Okay, good
((long pause, about 16 seconds. Pencil pointing to *N* on the graph, then moves up to the second intersection))
A: And um ((long pause about 12 seconds, pencil beats slightly down onto the intersection, then moves left))
So over here ((right of 2nd intersection)) we've got death rate. ((left hand moving to ordinate)) This is the death rate. So in this region ((pencil in region 3)) the death rate is higher than the birthrate (PICTURE 0.15.20) so the population is decreasing again. Um— so somewhere in the *mi*ddle (PICTURE 0.15.25) there was a change between these two. ((in-breath, slight laughter as if in exasperation)) ↓A::hh ((Pause)) The birth*rate* its— ((pause)) it means rate of change? °But the rate of° yeah, I see. ((5:55)) ((long pause, pencil moves from region 3 to region 1, to word "death rate")) Conser— conservation of such a species° ((long pause, pencil goes to the graph)) Well it just— ((pause)) feels that as long as the *birth*rate ((pause)) is increasing (PICTURE 0.16.23) faster than the death rate is increasing (PICTURE 0.16.26) then the population is in good shape. But when the population begins to decline, and the death rate stays the same ((pencil aligned with the death rate curve)) ((pause, pencil comes to left of intersection 2)) it's okay for a while (PICTURE 0.16.44) but eventually— clearly the ah population is going to diminish. Am I on the right track?
((rH on paper near text))
((pause))
D: Yup
A: Okay ask me a question then ((rH moves up to graph)) ((pause)) Where is your hi[nts?
D: [Um, u::m:, [um ((clears throat))
A: [It seems to me [you're in very good shape up to he[re
D: [em [okay
A: but as soon as it (PICTURE 0.17.09) begins to turn and come down you need to look at the situation as far as conservation goes because if that goes on for long=
D: =Uh hm
A: =You're going to fall below ah (PICTURE 0.17.13)
D: Okay
A: is going to be on— and your total number is going to is going to be on a decline which will be difficult to recover from because the slope (PICTURE 0.17.23) of this curve is quite steep at this point
D: Okay, that sounds reasonable. Um. Can you ((pause)) go further on this side here?
A: Give me a hint!
D: Well ((hesitating)) well, okay, as you can see, there is two intersection points
A: Yeah
D: and we ask you to, uh, to analyze the graph in the first section, second section, and in the third section. We [want—
A: [Oh wait a minute, wait a minute ((rH down to the text, begins to read)) Focus on the birth and death rates at the two intersection points of the lines, and on what happens to population sizes in the zones of population size below, between, and ab*ove* the inter[section
D: [Uh hmm
A: points. Okay now ((pencil moves up to the graph, first intersection point))
D: So to the left?
A: =It's the between I haven't really looked at, isn't it?
D: [Yeah].
A: [Yeah]. So you mean her[e ((circles region 1)) (PICTURE 0.18.00)
D: [Start in region one
A: There ((region 2)) and there ((region 3)) (PICTURE 0.18.03)
D: So start in region one and tell us in your opinion what, what, will happ'n, in your opinion what will happ[en to.]
A: [Here?] ((points to region 1))

D: Yeah, just over there.
((pause, Anne's pencil on region 1))
D: Because that would be the first region, below, right?
A: ↓Yeah.
D: So start in region one and talk about ((pause)) conservation of the species in *that* area.
((pause))
A: Well here the birthrate ((pause)) the birth *rate* in numbers per year presumably is still below the *death* rate ((long pause, 8:18)) but it— so it is rising— what I see is this is increasing ((follows death rate)) I'd want to plot another graph with it, I think, a bit
D: Go ahead
A: I'd like to sort of differentiate both these things ((gestures above the graph))
D: You can, you can draw it right on these
A: No no no, I am not going to draw it here.
D: Well, I—
A: Give me a clue
D: Well I think what's confusing you— you are thinking of uh— you are talking about the birthrate as the slopes on— of those curves— you are talking about
A: Yes
D: But *those* curves *are* the rates of change.
A: Ah, okay
D: So, the— the slope
A: This is the rate of change of birth? I see.
D: the rate of change of those curves would be like [the derivative of
A: [the second derivative, the [derivative of rate
D: [I don't know [if it would be the second derivative]
A: [((inaudible))]
D: But the derivative of the rate with respect to the population den[sity so
A: [right, so it's actually the second derivative of the po[pulation den[sity.
D: [Yeah. [so that's key to understand how this works
A: Uh hmm
D: So, so, so if your starting out in region one and the birthrate's lower than the death rate ((pause)) what do you think will happen to the population?
A: Well, the birthrate's *lower* than the death rate is ((pause)) the population's dwindling.
D: Okay.
A: Right.
((long pause))
D: Um okay, so okay, that makes sense. Now, now talk about the left intersection point— what will happen to the—?
A: birthrate is now above the death rate ((pencil points to the graph just above intersection 1))
D: No, right *at* the intersection
A: ((pencil moves to intersection)) Oh, intersection— is equal to the death rate.
D: So what will happen to the population at that
A: Well, it will stay the same
D: Okay. So now try above.
((Pause))
[((inaudible))]
A: [I can see that the birthrate is above the death rate and the population density is going to increase.
D: Okay
A: Yeah. ((Pause)) So that seems a good thing.
D: °Right°
A: But the ((pause)) the *rate* of increase is actually now ((follows birthrate from below to above intersection 1)) *drop*ping ((pause; pencil slowly follows curve further up))
D: But that doesn't

A: and after you go– I feel (ash–?) after you go over this peak
D: Yeah
A: It’s actually ((pause)) the rate of increase is now negative ((pencil on downward side of peak)) The, the, so, so, the rate
D: Well,
A: Is born at is dropping off.
D: But the value of the rate is still *pos*itive because we are plotting the rate–
A: Oh, yes you are, yes
D: Yeah ((pause)) that’s key to this graph
A: Okay. The value of the rate here

(()) is still positive ((pause)). Okay. It's quite high in fact.
D: Hmm. It still is.
A: Uh hmm. But the *death* rate here ((intersection point)) is the same now ((pause)) as the birthrate
D: °Okay°
A: And so we are back to a steady population. ((11:25))
D: Okay.
A: ((long pause)) and, after that the death rate

((
is again higher than the birthrate ((pause)) so the population’s ((pause)) going to ↑drop ((pause)) again. Is that right?
D: Oh, I [do
A: [What did I miss?
D: ↓Okay. So, um, so if– I think what your missing is the relationship– that um ah well this graph is the– um the rate is the function of the population if um– if that *N*– IF
A: Oh, it says a function of the population
D: Well, population of *den*sity
A: Okay, I only *just* focused on this *N* ((circles N))
D: Okay. So now–?
A: OH, RIGHT. Okay, ↑so
D: Okay
A: It’s a population as a function of *den*sity and the death rate goes up proportional to the population ((pause)) density ((pause)) Is that right? It’s a line
D: Well it’s a , it’s a, it’s some function of N. Because it, it’s a linear function of N because it
A: =Yeah, I mean why are we–I don't even know if this is a linear or a log plot.
D: Um
A: I assume it’s a linear
D: I think you can assume it is linear. So that death rate is um is like death rate is equal to some constant alpha times *N.*
A: ↑Right
D: plus some intercept, right?
A: ↓Right.
A: I mean right, okay. ((long pause)) But the birthrate goes as *N* minus N-squared. So as the population gets righ– (0.62) gets (0.65) I’m just– (0.40) just beginning to wake up to what this is saying. (0.90) As the population gets greater the birthrate falls off for various reasons one of which is suggested here. (0.60) And in the end the population will